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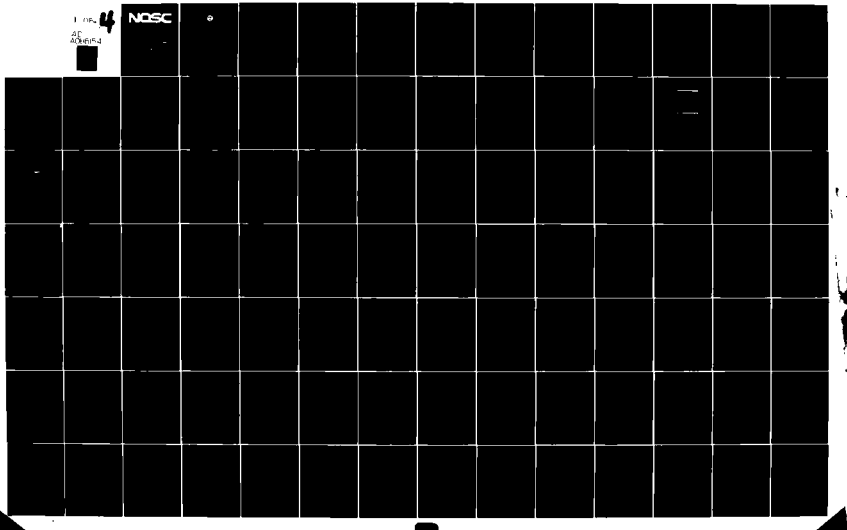

# NOSC





**Technical Document 314**

# AERIAL SURVEYS OF BOWHEAD WHALES, NORTH SLOPE, ALASKA

11 Feb[redacted]80

12 D.K./Ljungblad
M.F./Platter-Rieger
F.S./Shipp, Jr.





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Aug - Oct 79.
Prepared for
Bureau of Land Management

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During 1979 fall aerial surveys (August, September, and October), 134 individual or group sightings of bowhead whales were made in an area ranging from Point Barrow to Demarcation Bay along the North Slope of Alaska and primarily along the 10-fathom line. Of the 249 bowhead whales sighted, one group of six was observed inside the oil lease area near Narwhal Island, and 84 were seen to the north and outside the oil lease area along the 10-fathom line. No bowhead whales were seen in or about the lease area during the spring (April - May) or the summer (June - July). Behavioral observations and statistical analysis of initial whale headings indicate that the majority of bowhead whales seen during August, September, and October were migrating in an unhurried manner.

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They were observed heading in many directions, with estimated speeds of 1.0 knot or less and were possibly feeding along the way. Thirteen tapes containing bowhead whale vocalizations of a quality suitable for analysis were recorded. Preliminary analysis indicates that the sounds are of a slightly higher frequency in the fall. The average overall frequency ranges of the spring and fall sounds were 30 to 2000 Hz and 30 to 3500 Hz, respectively. The peak migration began within an 11-day period between 27 September and 7 October 1979, and continued until 17 October 1979. The total numbers of whales traveling through the survey area were estimated (within 95% confidence limits) to be $852 \pm 533$ for a 21-day migratory period and $1620 \pm 1051$ for an 11-day period. These estimates are only preliminary approximations and are based upon untested assumptions about bowhead whale migratory speeds and behavior, 22 usable sightings, and an assumed migratory speed of 0.25 knot.

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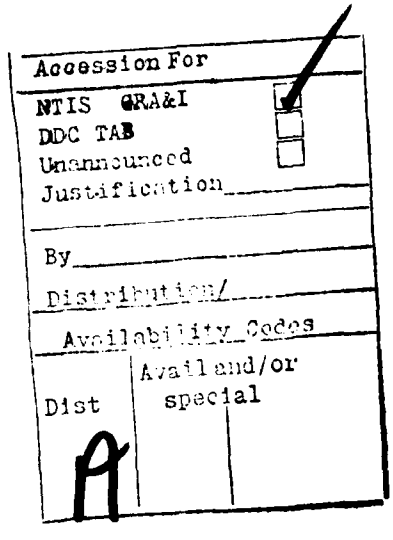

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## INTRODUCTION

The bowhead whale, *Balaena mysticetus* (appendix A), which inhabits the Bering, Chukchi, and Beaufort Seas, is on the endangered species list. Bowhead whales annually migrate from the Bering Sea in the spring (April, May, and early June) north and east into the Beaufort Sea and east to the MacKenzie Delta-Banks Island area and the Amundsen Gulf area located in Canadian waters. In early or mid-September, they make a westerly return migration from Canadian waters past Point Barrow, and south to the Bering Sea.

These migrations take bowhead whales through areas currently under development or being assessed as potential sources of mineral and oil resources. There is concern that resource-related development associated with such activities may have an effect on whales that frequent these areas.

In 1979, the Bureau of Land Management (BLM) funded the Naval Ocean Systems Center (NOSC) to conduct a study to determine occurrence, estimate population density, observe behavior, and record vocalization patterns of bowhead whales in the vicinity of the proposed Beaufort Sea oil lease area. Using aerial survey methods, north-south line transects were flown in and about the oil lease area. This report describes the study and presents its results.

## AERIAL SURVEY

### METHODS

#### Objectives

To investigate the occurrence, population density, and behavior patterns of endangered whales in the vicinity of the Beaufort Sea lease areas.

#### Design

The following four areas were selected for the survey:

1. Block #1, which includes the oil lease area.
2. Block #2, north of the oil lease area.
3. Block #3, east of the oil lease area.
4. Northwest, north of Harrison Bay.

These areas are identified in figure 1. The major emphasis of the survey was Block #1 which included the oil lease area. The other areas were only surveyed when bad weather precluded surveying Block #1 or it had just been surveyed and no whales had been seen.

The following sampling design (Leatherwood, 1979) was constructed for Blocks #1, #2, #3, and Northwest for flights within these areas:

1. The area was divided into six sections running north-south.

2. Each flight surveyed one north-south transect within each of the six sections and the necessary connecting paths (generally east-west) between the north-south transects.

3. The north-south transects were chosen within each section by picking two numbers between 1 and 20 from a random numbers table, matching them to the numbered marks

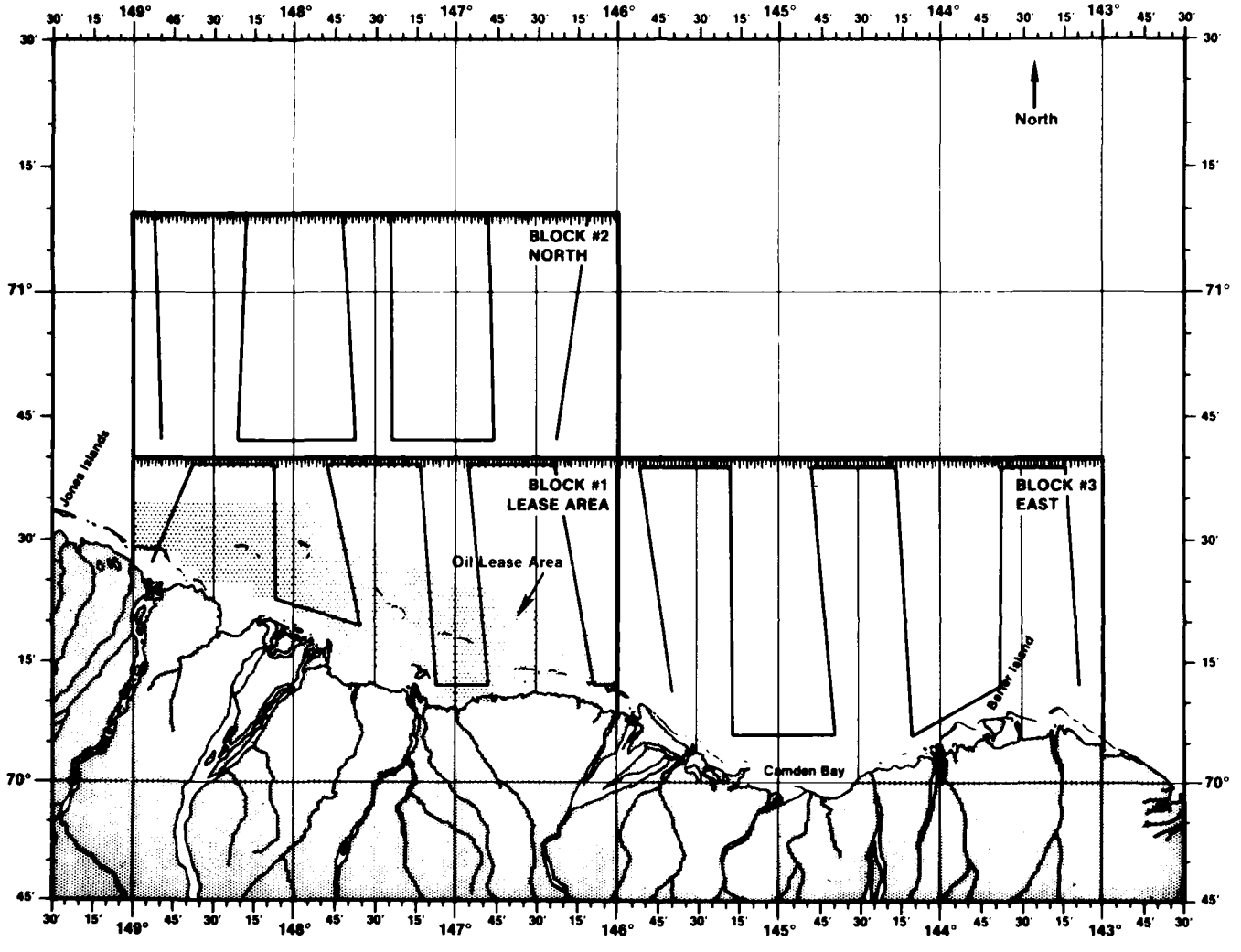



Figure 1. Example of how preplanned line transects were laid out in Blocks 1, 2 and 3.

placed at the section's top and bottom, then drawing the transect between them. The same procedure was followed for each section within the area to be surveyed.

Figure 1 shows an example random design.

## Procedures

Each survey flight began by selecting the area to be flown. Special emphasis was placed on Block #1, which includes the oil lease area, with Blocks #2, #3, and Northwest of Block #1 being the alternate choices. Prior to each survey flight, the selected transect positions (turning points) were programmed into the aircraft's navigation system which was then calibrated at a known location. Surveys were flown at altitudes between 30 and 305 m (100 and 1000 ft) and averaged 244 m (800 ft). The intention was to maintain 305 m (1000 ft) of altitude, but flights varied according to weather conditions. Airspeeds varied between 183-201 km/h (114-125 knots).

The observers and a pilot (who also acted as an observer) were positioned so that the person who was navigator, main observer, and recorder was in the copilot's seat, with the other observers in a left rear, right rear arrangement. The pilot and all observers were connected to a common communication system and each observer, except the pilot, was provided with a clinometer and observation log.

For all marine mammals sighted, whether whales, polar bears, or pinnipeds, the following information was recorded whenever possible: species identification, position coordinates, time, and number in the group. For whales, a clinometer angle was taken when the sighting was abeam of the aircraft. The altitude and magnetic heading of the aircraft along with the transect side where the sighting occurred were also recorded, along with the heading of the whales relative to that of the plane and the whales' behavior.

On sightings of one or more bowhead whales, a sonobuoy was dropped and a recording was made as the aircraft circled the area. In addition, on most survey flights one or two sonobuoys were dropped at random in areas where no whales were sighted in an attempt to check for their possible presence acoustically.

Statistical tests designed to examine patterns of animal movement (Batschelet, 1972) were applied to the initial headings of whales seen on days where a sufficient sample was collected. These included the V-test, to detect significant clustering around the predicted westerly migratory direction of 289° (270° adjusted for the northwest slope of the coastline), and Rao's test, which detected significant swimming directions other than the predicted 289°.

All sightings were plotted on a chart, and the possible repeat sightings were checked by calculating distances based on an assumed speed of 1 nmi/h. The time between sightings and the whales' speed were used to calculate the probable distance traveled. Any sighting that was within range of an earlier sighting was considered a resighting and was automatically ineligible for use in the density estimate.

## Equipment

The aircraft used in this study was a DeHavilland Twin Otter 300, complete with an OnTrack III navigation system. The OnTrack III provided a continuous position update, along with distance from the aircraft position to a transect point and correction for the aircraft's drift from the programmed course.

## RESULTS

### General

From July through October 1979, 63 survey flights over Blocks #1, #2, and #3 and northwest of Block #1, as well as in the vicinity of Point Barrow, were completed. Fifteen and one-half flights of opportunity were flown. They included trips to Point Barrow for aircraft maintenance, flights to Demarcation Bay, and flights to areas of good visibility, which were used as alternates when the survey team was fogged or iced out of Block #1. The number of flights per area by month is shown in table 1, which also lists flight time per month; details of all survey flights completed are shown in appendix B. However, the two flights made in July are not listed in appendix B because, for safety reasons, they were not complete transects.

The locations and headings of all bowhead whale sightings are plotted in figure 2. A more detailed monthly breakdown of aerial survey effort and results follows.

### July

Two flights were made during July, on the 10th and 24th. Both originated from Point Barrow and terminated at Flaxman Island, located in the eastern edge of the oil lease area, Block #1. Both flights were conducted in a single-engine aircraft, were limited to near the shoreline, and were flown at altitudes ranging from 610 to 1220 m (2000 to 4000 ft) for safety reasons. No sightings were noted on either flight.

### August

The August effort was based at Point Barrow until the 15th. During this period, four flights were made to the lease area and four surveys completed. The coastline was followed on returning to Pt. Barrow from the lease area to look for stranded whales. No sightings or strandings were observed on these flights (2-15 August).

On 15 August the survey team's base of operations was moved to Flaxman Island on the eastern edge of the lease area. This move provided instant weather information for the area of study, and allowed flights to be made at a moment's notice. In four sightings, five bowhead whales and one large unidentified whale were observed in Block #3, flights 9 and 10 (20-21 August 1979), which constituted the only whale sightings for the month. Detailed information on the August surveys is provided in appendix B, flights 1-17.

### September

In September, the base of operation remained at Flaxman Island until the 9th, then at Bullen Point until 15 September when boat support was withdrawn because of the expected freezeup. The aircraft and survey team then moved to Deadhorse, at Prudhoe Bay, for the duration of the study. Fifteen days of fog and bad weather grounded the aircraft during September. Twenty-six flights were completed in September. The 29 bowhead whale sightings made on these flights are shown in table 2. More detailed information is contained in appendix B, flights 18-41.

| | Areas Surveyed | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date | Block #1 | Block #2 | Block #3 | Northwest | Demarcation Bay | Barrow to #1 and return, or vice versa | Transects in vicinity of Barrow | Hours of flight Time |
| July | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 10 |
| August | 10 | 1 | 7 | 0 | 0 | 5 | 0 | 80 |
| September | 11 | 2 | 8 | 0 | 2 | 3 | 0 | 82 |
| October | 15 | 3 | 2 | 2 | 0 | 3.5 | 2 | 105 |
| Totals | 38 | 6 | 17 | 2 | 2 | 13.5 | 2 | 277 |

Table 1. Completed survey flights made in the Twin Otter are listed by area for August, September, and October. Only two flights from Point Barrow to the lease area and return were made in July. These flights were made in a single-engine aircraft, which limited the area of survey to the coastal zone for safety reasons. No sightings were noted. Details on flights made in July, August, September, and October are listed in appendix B.

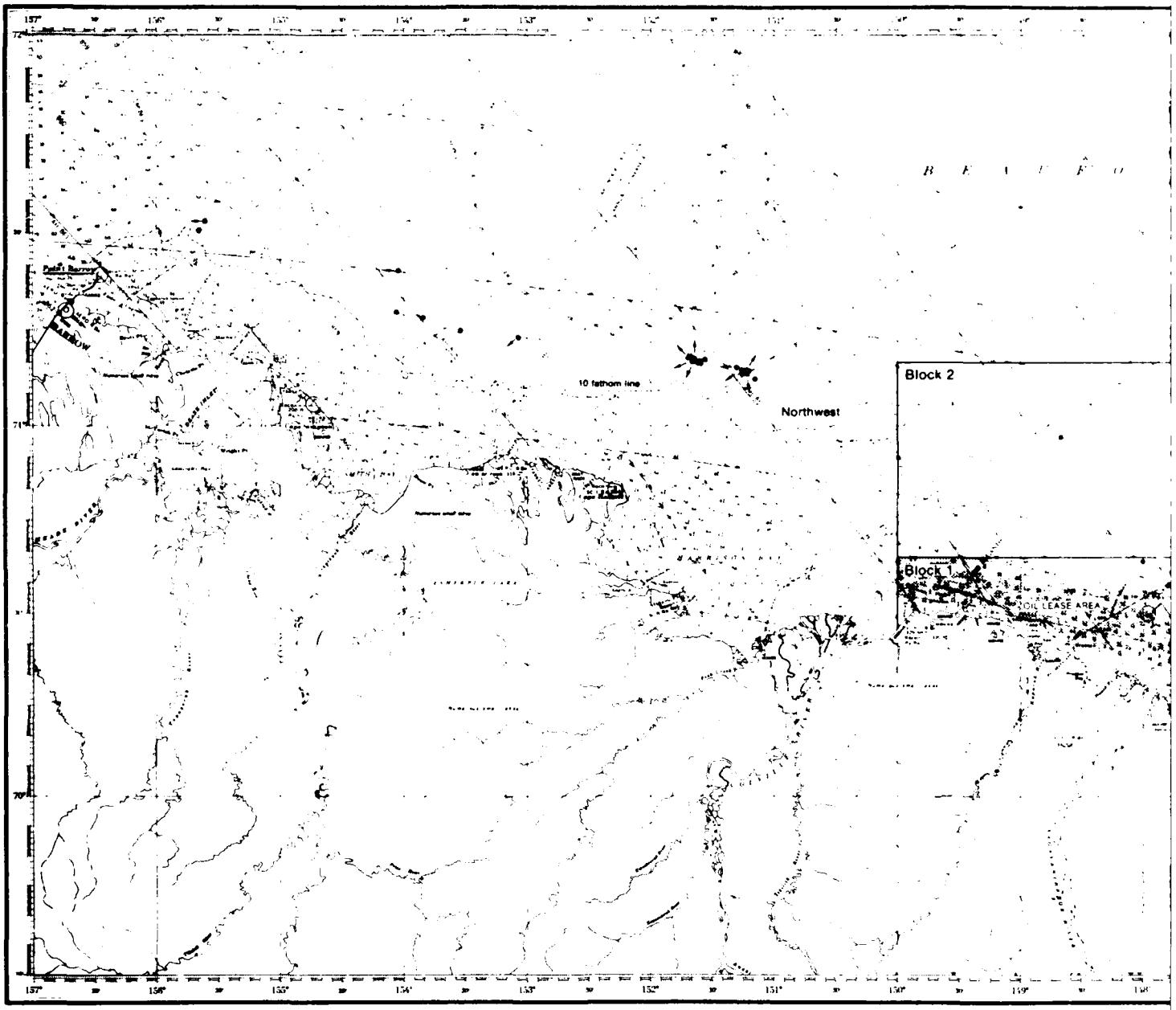
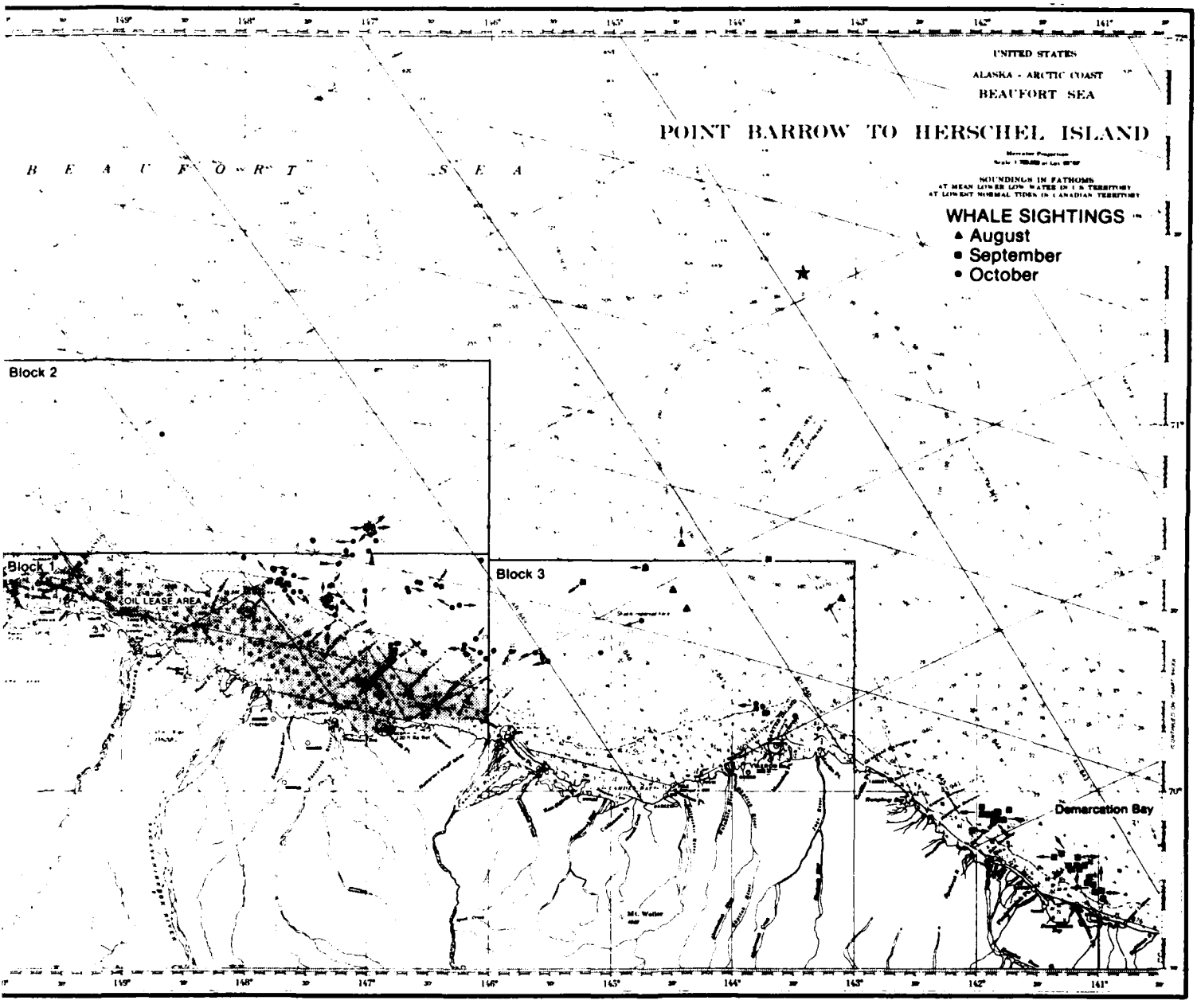



Figure 2. Bowhead whale sighting chart for August, September, and October 1979. Each position represents an individual or a




ition represents an individual or a multiple sighting. Arrows indicate general headings. Each sighting is detailed in appendix B.

| Date | Flight | No of Sightings | No of Whales | Area |
|---|---|---|---|---|
| 7 Sept | 21 | 2 | 2 | Block #3 |
| 18 Sept | 32 | 1 | 2 | Block #3 |
| 24 Sept | 37-A | 1 | 1 | Block #3 |
| 24 Sept | 37-B | 10 | 35 | Demarcation Bay |
| 26 Sept | 39-A | 1 | 2 | Block #1 |
| 26 Sept | 39-B | 14 | 40 | Demarcation Bay |
| TOTALS: | | 29 | 82 | |

Table 2. Total bowhead whale sightings made in September 1979.

**October**

In October, the base of operation remained at Deadhorse, Prudhoe Bay, until the freezeup was complete. At the request of the Bureau of Land Management, operations were then transferred to Point Barrow and two complete north-south surveys were run north of Point Barrow.

From 1 October through 7 October, aircraft support for the surveys was withdrawn by the Naval Arctic Research Laboratory (NARL) pending resolution of funding for Project Whales as well as a routine 100-hour check on the aircraft. During this period, three flights were conducted by NARL, with the sightings noted by Mr Lloyd Zimmerman, NARL pilot, presented in table 3. These sightings are included in figure 2 of the fall overall sighting chart.

All bowhead whale sightings made by the aerial survey crew after aircraft support was again provided by NARL on 8 October 1979 are listed in table 4. Details on sightings made on routine transit flights to and from Barrow are in table 5. Additional information on survey flights and sightings can be found in appendix B.

The beginning of peak fall migration apparently occurred between 27 September and 7 October, and migration past the lease area apparently ended by 17 October, starting on 21 October, six flights over Block #1, one over Block #2, one over Block #3, and one to the Northwest of Block #1 failed to reveal any whales in these areas.

**Behavior**

The first behavioral information was collected on 24 September, when the survey team flew a line transect (flight 37A and 37B) 40 miles east of Barter Island. The weather was clear with unlimited visibility, and the sea was calm. The central area of sightings was located at 69 °55′ 54″ N,141 °46′18″ W, within an area of approximately 5 square miles near Demarcation Bay. Ten individual sighting positions were noted (flight 37B and table B6, appendix B). The number of whales observed at each position ranged from a maximum of 10 in one group down to one.

In this area, whales were observed on the surface almost at regular intervals and gave the impression of resting between dives; then, suddenly, no whales would be seen in any

| Date | Position | Sighting |
|---|---|---|
| 1 Oct 79 | T3-Ice Island, approx 126 nautical miles north of Barrow | Beluga |
| 6 Oct 79 | 70°23'30" N 145°58'30"W | 2 bowheads |
| 6 Oct 79 | 70°12'42" N 143°29'36"W | 2 bowheads |
| 6 Oct 79 | 70°13'06" N 143°44'24"W | 3 bowheads (1 large cow with small calf; 1 separate adult) |
| 6 Oct 79 | 70°14'12" N 143°45'24"W | 1 bowhead |
| 6 Oct 79 | 70°14'48" N 143°48'30"W | 1 bowhead |
| 7 Oct 79 | 70°34'24" N 146°34'18"W | 1 bowhead |
| TOTAL | | 10 bowhead whales |

Table 3. The whale sighting positions given here were provided by Mr Lloyd Zimmerman. They differ from those in the NARL Interim Status Report of 25 October 1979, which were given only to the nearest minute of longitude and latitude.

quadrant for several minutes. The average time between sightings was 8 minutes for the 1.5 hours of observations in this area.

*The whales' swimming behavior* was slow and easy, and included milling about or lying stationary. The direction of headings appeared to be random (table B6, appendix B). There was little or no response by the whales to the aircraft, even when low altitudes were flown for purposes of photography or sonobuoy drops.

Four sonobuoys were dropped and, considering the number of whales present in the area, the results of the recording sessions were disappointing. The vocalizations were few in number and were separated by several minutes each.

On 26 September, a second flight (39A and 39B) was made to the same general area observed on 24 September. The weather conditions were again clear and the sea was calm. The central area of the sighting positions was 69°46'48"N, 141°08'30"W (figure 3). Fourteen bowhead sightings were noted, of which two were considered repeat sightings (flights 39B and 39A, table B7, appendix B). The maximum number of whales seen at any one location was nine and again, the headings appeared random.

The behaviors observed were basically the same as those seen on 24 September, with only one difference noted. All the whales observed were at the surface almost continuously, and no dive periods were noted. Sonobuoys were again dropped with the same results; very few vocalizations were recorded.

The observations noted on these two flights could indicate a possible feeding area. During September and October, the bowhead whales did not appear to be hurrying single-mindedly westward to finish their fall migration. Instead, the general impression received about bowhead whale behavior at Demarcation Bay in September, and throughout the survey areas in October, was one of whales tending to head in all directions, rather than just westward. It is possible that these whales were pausing to feed or engage in other behaviors.

| Date | Flight | No of Sightings | No of Whales | Area |
|---|---|---|---|---|
| 8 Oct | 42 | 6 | 9 | Block #1 |
| 11 Oct | 43 | 3 | 10 | Block #1 |
| 11 Oct | | 1 | 5 | Transect west from Barrow |
| 12 Oct | | 1 | 1 | Transect east from Barrow |
| 13 Oct | 44 | 9 | 10 | Block #1 |
| 14 Oct | 45 | 35 | 44 | Block #1 |
| 15 Oct | 46 | 3 | 3 | Block #1 |
| 15 Oct | 47 | 13 | 16 | Block #2 |
| 16 Oct | 48 | 7 | 11 | Block #1 |
| 17 Oct | 49 | 2 | 2 | Block #1 |
| 18 Oct | 51 | 1 | 1 | Block #3 |
| 19 Oct | 53 | 20 | 31 | Northwest of Block #1 |
| 20 Oct | 54 | 1 | 1 | Block #2 |
| 20 Oct | 54 | 1 | 1 | Block #1 |
| 21 Oct | | 3 | 3 | Transect west to Barrow |
| 22 Oct | | 1 | 3 | Transect east from Barrow |
| 25 Oct | | 1 | 1 | Transect east from Barrow |
| Totals: | | 108 | 152 | |
| From Table 3: | | 6 | 10 | |
| Grand Totals: | | 114 | 162 | |

Table 4. Total bowhead whale sightings made in October 1979.

| Date | No of Whales | Latitude N | Longitude W | Altitude (ft) (m) | Clinometer Angle, degrees | Heading, degrees | Behavior Comments |
|---|---|---|---|---|---|---|---|
| 11 Oct 79 | 5 | 71°14'00" | 153°04'00" | 300 91 | 11 | 225 | All dived. |
| 12 Oct 79 | 1 | 71°24'36" | 154°02'54" | 500 152 | 12 | 270 | Dived. |
| 21 Oct 79 | 1 | 71°17'00" | 153°50'30" | 350 107 | 5 | - | Dived immediately. |
| 21 Oct 79 | 1 | 71°18'06" | 154°03'42" | 350 107 | 10 | - | Dived. |
| 21 Oct 79 | 1 | 71°30'30" | 155°39'54" | 300 91 | 13 | 253 | Dived. |
| 22 Oct 79 | 3 | 71°32'00" | 155°36'18" | 500 152 | 45 | 273 | Size range was 25-30 ft (8-9 m). Seen in an open lead. Dived. |
| 25 Oct 79 | 1 | 71°15'12" | 153°32'24" | 500 152 | 40 | | Dived. |

Table 5. Bowhead whale sightings on flights to and from Point Barrow, 1979. Perpendicular distances are included only for those sightings used to calculte the density estimate. All of these whales were considered original sightings, with no resightings.

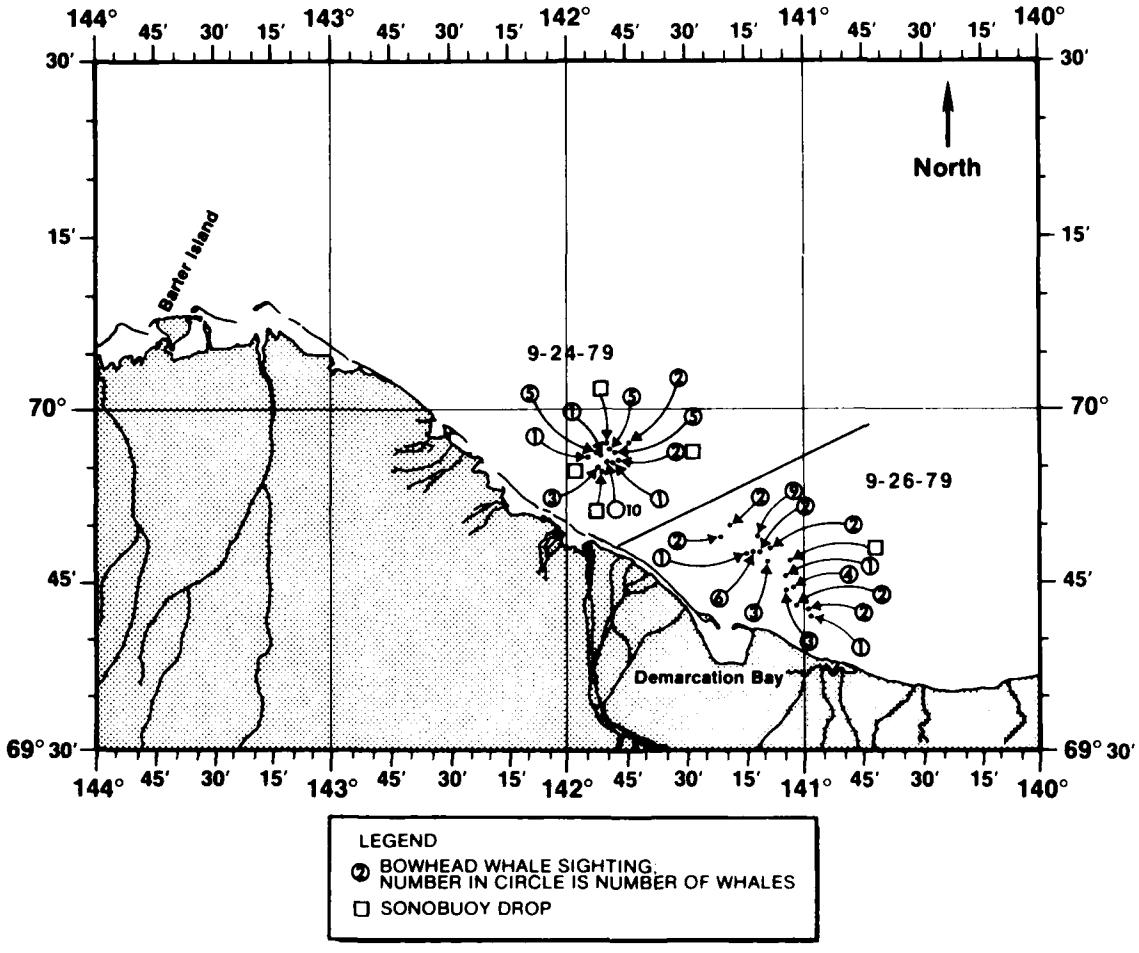



Figure 3. Combined sightings of flight 37-B and 39-B, 24 August and 26 August 1979, Demarcation Bay, which indicate a possible feeding ground for bowhead whales.

The 14 October observation, with n=31 individual headings in Block #1, showed highly significant ($p \leq 0.01$) clustering around an average easterly direction (111°±95% confidence limits of 33°). The 15 October observation, with n=17 individual headings in Blocks #1 and #2, showed a barely significant ($p \leq 0.10$) trend toward clustering. No one mean direction could be calculated, since the clustering occurred around several different directions. Not until 19 October, with n=18 individual headings, did a significant ($p \leq 0.05$) clustering around the predicted westerly migratory direction of 289° occur. The calculated mean direction for 19 October was 256 ±95% confidence limits of 70°. The only bowhead whales seen during October that appeared to be purposely migrating were 11 which were observed between Harrison Bay and Point Barrow from 11 to 22 October. They showed highly significant clustering ($P \leq 0.001$) around the predicted migratory direction.

Other behaviors seen in October also contributed to the impression of unhurried travel. Seven bowhead whales were seen which were initially not moving at the surface (table 6). The whale seen on 8 October was lying in the water at a 45° angle with its rostrum in the air, pointing west.

| Date | Flight | No of Sightings | No of Whales | Survey Area |
|---|---|---|---|---|
| 8 Oct | 42 | 1 | 1 | Block #1 |
| 14 Oct | 45 | 2 | 4 | Block #1 |
| 15 Oct | 47 | 1 | 1 | Block #2 |
| 17 Oct | 49 | 1 | 1 | Block #1 |
| TOTALS: | | 5 | 7 | |

Table 6. Sightings of bowhead whales that were not moving.

On three separate occasions, distinct groups of bowhead whales were observed milling slowly around on the surface. On 11 October (flight 43), a loosely scattered group of at least six whales was seen about 2.5 nmi northwest of Narwhal Island, Block #1. They were milling around in all directions at the surface and were diving frequently. At least two whales dived with their flukes thrown clear of the water, which usually indicates a deep dive, even though the water there was shallow, only 10 fathoms or less. The water was brown, with a reddish tinge and streaks of blue. It was suspected that these whales were feeding. Several sonobuoys were dropped and vocalizations were recorded. On 16 October (flight 48), four bowhead whales were observed at the surface and near the edge of a large open lead surrounded by solid but thin ice at the east edge of Block #1. They were very slowly milling about on the surface. Individuals would occasionally dive under the ice, then pop back out, slowly rise to the surface and blow, then just as slowly and unhurriedly sink down. The area was circled for 1.5 hours while recording vocalizations from a nearby sonobuoy which had been dropped in the same lead.

On the 19 October flight 53, two groups of whales, numbering five and six individuals, were seen northwest of Block #1. Sonobuoys were dropped but no vocalizations were recorded. Also seen in the same general area were 15 to 20 belugas (*Delphinapterus leucas*). They were evenly spaced and were proceeding quite steadily in straight, regular lines on a northeasterly heading (63° true). This was the only group of belugas seen in the fall.

No cow-calf pairs were seen in August or September, but six separate pairs were seen in October (table 7). These pairs constituted only 5% (total), 11% (original), or 1% (estimated) of all the whales seen. Four of these sightings were of a large whale closely accompanied by a very much smaller whale, but the cow-calf sighting of 13 October 1979 (flight 44) in Block #1, was different. A small whale, about 6 to 8 m (20 to 25 ft) long, was first seen swimming slowly at the surface, heading south. Four minutes later, a large whale surfaced near the smaller one. None of the cow-calf pairs stayed at the surface for more than 1 to 3 minutes from the initial sighting.

### Summary

During the 1979 fall survey (August, September, and October), 134 individual or group sightings of bowhead whales were made. These sightings were in an area ranging from Point Barrow to Demarcation Bay and primarily along the 10-fathom line. Of the 249 bowhead whales sighted, one group of six was inside the oil lease area near Narwhal Island, and 84 were in Block #1, but outside the oil lease area.

Because of the lack of sightings in the lease area, all of the sightings in Block #1 were used to determine a density estimate.

When comparing behaviors observed in the spring to those of the fall, some differences were noted. In most spring sightings, the whales' reaction to the aircraft was immediate and most would dive. In the fall, during September, most whales remained on the surface, even if the aircraft circled the sighting area for extended periods of time. During October, when the majority of whales was sighted, responses to the aircraft were noted, but they were not as dramatic as in the spring.

The estimated swimming speed of 3 nmi/h for the spring agrees with observations by Braham et al (1978). The direction in which the whales were heading during the spring was predictable and consistent with what one would expect of a migrating whale.

In the fall, behavioral observations and statistical analysis of initial whale headings indicate that the majority of bowhead whales seen during August, September, and October were migrating in an unhurried manner, and groups were observed heading in many directions, with estimated speeds of 1.0 knot or less, and possibly feeding along the way.

## ACOUSTICS

### OBJECTIVES

The purpose of this effort was to record sounds produced by the bowhead whale. These sounds are to be analyzed to determine the overall frequency content, in hopes that they can be used in assessing the hearing capabilities of the bowhead whale – on the theory that whales can hear the sounds they produce.

### METHODS

Bowhead whale vocalizations were recorded with two available types of AN/SSQ-41A (frequency response from 10 Hz to 5 kHz) and the AN/SSQ-57A (frequency response 10 Hz to 20 kHz) sonobuoys. A sonobuoy is a passive listening device containing a hydrophone array and vhf transmitter. When dropped from an aircraft, its descent is slowed by a rotochute or parachute. Once contact with the water is made, a saltwater-activated battery

| Date | Flight No | Survey Area | No of Sightings | No of Whales | Comments | Latitude N | Longitude W |
|---|---|---|---|---|---|---|---|
| 6 Oct | – | Block #3 | 1 | 3 | 1 large cow with small calf, 1 separate adult, sighted by Lloyd Zimmerman. | 70°13'06" | 143°44'24" |
| 8 Oct | 42 | Block #1 | 1 | 2 | 1 large cow with small calf, possibly the same pair seen on 6 Oct. | 70°40'54" | 147°07'12" |
| 13 Oct | 44 | Block #1 | 1 | 2 | 1 small whale (20-25 ft long) at surface headed south; 1 huge whale surfaced near and joined the small whale. | 70°24'18"<br>70°24'06" | 146°46'30"<br>146°48'36" |
| 14 Oct | 45 | Block #1 | 2 | 5 | 1 cow with small calf;<br>1 cow and calf with 1 separate adult. | 70°35'00"<br>70°34'24" | 147°42'42"<br>147°39'54" |
| 16 Oct | 48 | Block #1 | 1 | 2 | 1 cow about 35 ft (11m) long with a small calf about 15 ft (5m) long. | 70°25'06" | 146°06'54" |

Table 7. Bowhead whale cow and calf pairs seen in October 1979.

energizes the unit. At this time, the parachute assembly is jettisoned and the hydrophone array is dropped to a preselected depth, either 18 or 92 m (60 or 300 ft). The sounds picked up by the hydrophones are amplified, telemetered to the aircraft receiver, and recorded.

Vocalizations were recorded with a broadband receiver (Defence Electronics GPR-20) coupled to a dual-track Nagra IV SJ tape recorder. Signals were monitored via headphones while recording on one track, and notes about behavior and the presence or absence of vocalizations were made on the second track.

On most survey flights, one or two sonobuoys were dropped at random in areas where no whales were sighted in an attempt to check for their possible presence acoustically.

In August through October, sonobuoys were dropped for monitoring and for recording possible vocalizations at whale sightings. Appendix B shows numbers and locations of drops. Drops were made during survey flights to monitor for whale vocalizations even though no sightings had occurred, and were generally made at random on the northern edge of the survey track to take advantage of the deeper water. Results were negative with respect to whale vocalization on all of the randomly placed sonobuoys.

Sonobuoys were dropped at the majority of whale sighting positions. In the event of several sightings within a small area, a centralized drop was attempted. One or more sonobuoys were used if the positions of the sightings covered a large area. This practice maximized the chances of obtaining good recordings. When more than one sonobuoy was present in the same area, all the sonobuoys were monitored and the best sounds with respect to signal-to-noise ratio were recorded. From August through October, the sounds recorded were whale vocalizations and the geophysical sounds originating in or near the lease area.

## RESULTS

Sounds attributed to geophysical exploration were recorded several times in the month of September, both in the lease area and also outside the lease area. The recordings of the geophysical sounds made on 19 and 25 September are of particular interest because of the ranges at which they were detected and the association with a whale sighting. The origin of the geophysical sounds was not known in early September and an effort was made to locate the source. Our investigation showed that Western Geophysical Company of America has been conducting geophysical surveys in the lease area for the past 7 years. During these surveys, techniques are used with a source level of 248 db (±10 dB) re 1 $\mu$Pa at 1 m.

A recording of the suspected oil exploration sounds was played back for Mr Jim Benton of Western Geophysical Company of America, which operates out of Prudhoe Bay, Alaska. He confirmed that the 12- to 14-second duration of the recorded sounds was approximately the same as that used by his boats during their surveys. According to his account, the position of the source on 19 September was at 70°20'00" N 146°00'00" W ( figure 4). The first sonobuoy dropped during flight #33, Block #1, was at 70°38'42"N 147°06'54"W, which placed it 30 nautical miles from the source. The second sonobuoy was dropped in Block #3 at 70°38'06"N, 143°09'48"W, 60 nautical miles from the source. These recordings were analyzed and showed an overall frequency content of 75 to 1250 Hz, with the maximum energy at about 300 Hz. Figure 5A-B gives examples of the sounds recorded on 19 September at the two locations.

The effect of range and gain increases on recording can be seen in the examples by comparing the noise and the high-frequency component of 1250 Hz in figure 5A to the

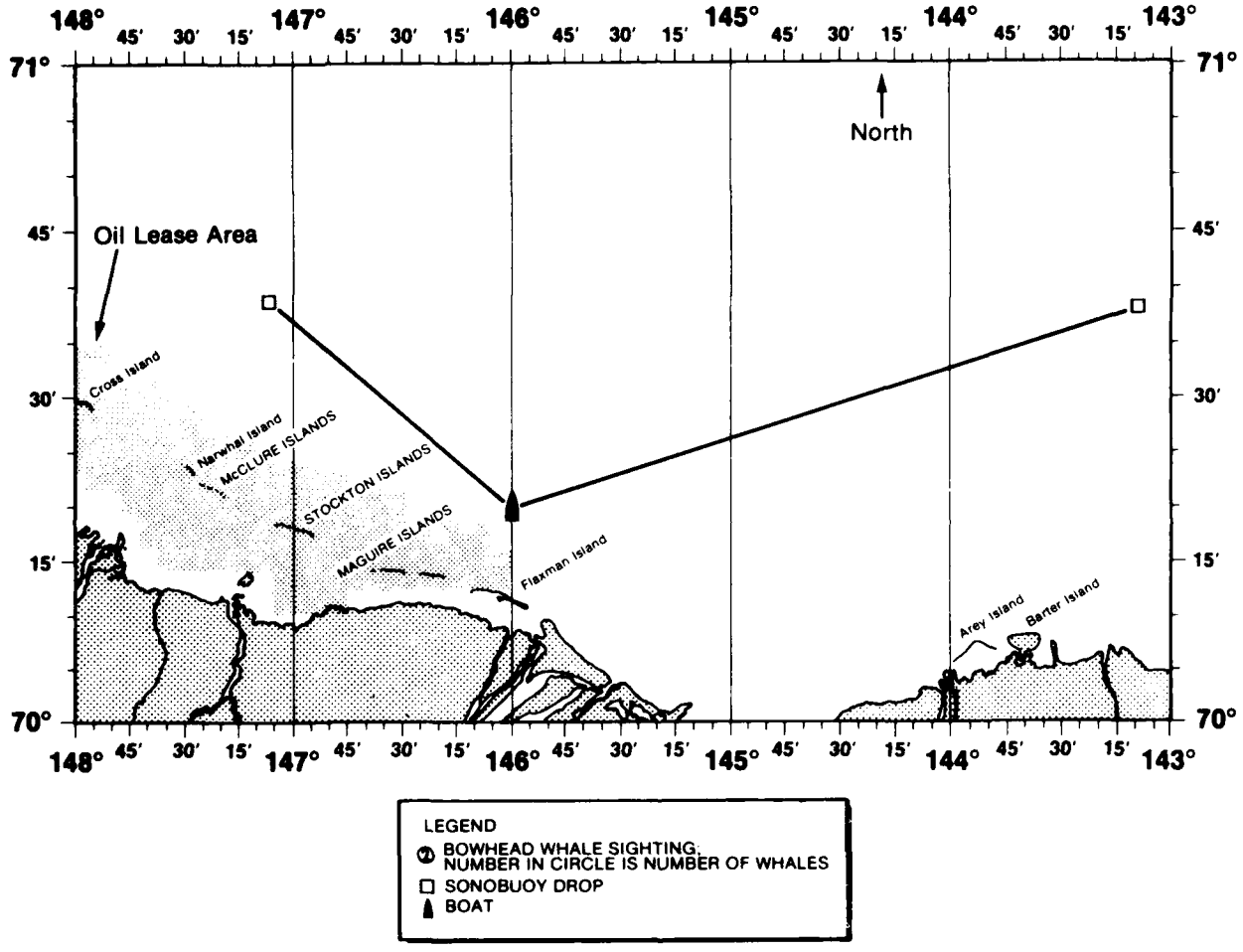



Figure 4. Flights 33 and 34, 19 September 1979, were combined to show overall distance from sonobuoy drops to the geophysical boat position.

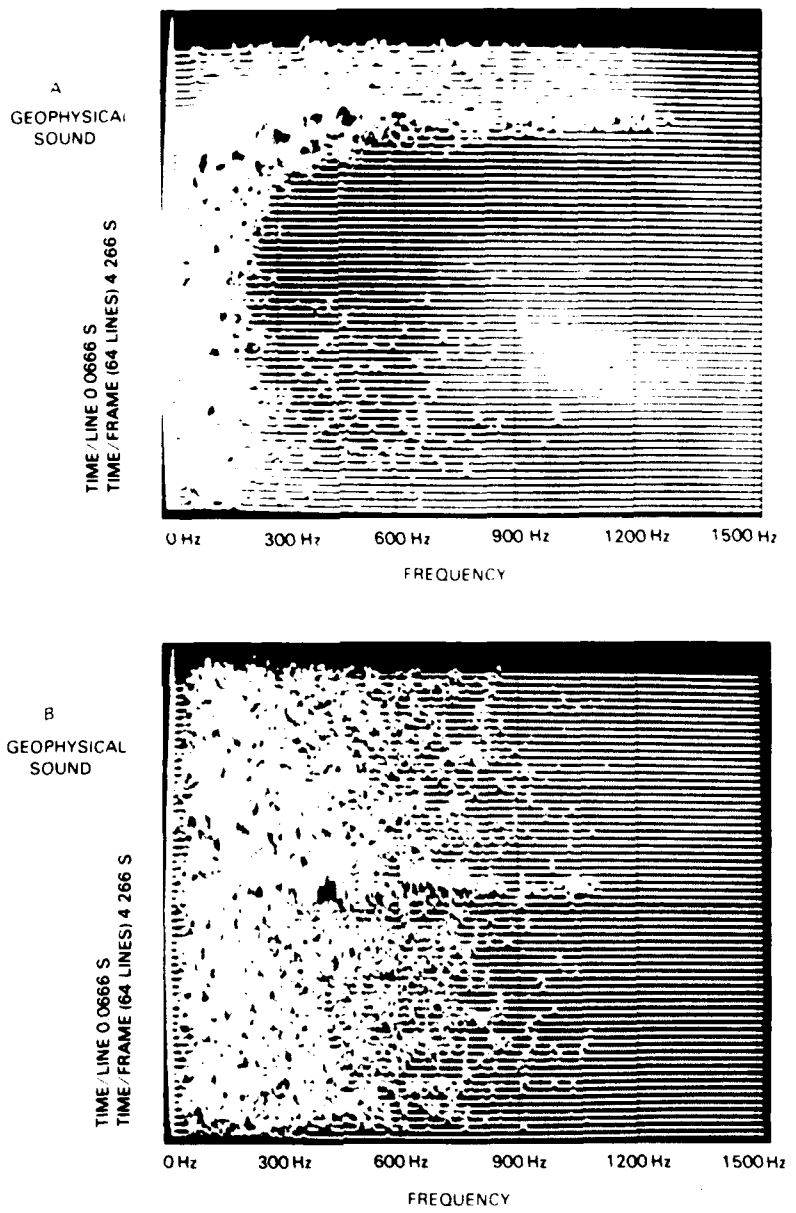



Figure 5. A) A geophysical sound that was recorded 29 nautical miles away from the source, at 70°38'42"N, 147°06'54"W, Block #1 (flight 33, 19 September 1979). B) A geophysical sound that was recorded 60 nautical miles away from the source at 70°38'06"N, 143°09'48"W, Block #3 (flight 34, 19 September 1979). Differences noted between examples are the result of distance and recorder gain settings.

noise and high-frequency component of 1050 Hz in figure 5B, which was recorded at a range of 60 nautical miles.

The sighting of two bowhead whales at 70°23'06"N, 146°32'30"W on 26 September, flight #39-A, deserve special attention with regard to oil exploration sounds and possible bowhead vocalization. The position of the recording placed the two whales approximately 2 miles north of the lease area (Block #1). When sighted, the animals were on the surface heading west. Their immediate reaction to the aircraft was to dive, and they were not sighted again. A sonobuoy was dropped within the area of sighting and a recording was made. Two hours later, a second flight (40) was made. On this flight, no whales were sighted but the positions of three geophysical survey boats were noted; one sonobuoy was dropped and a recording made. Figure 6 shows the positions of the whales previously sighted and the positions of the geophysical boats and sonobuoy drop. Because of the 2-hour difference between flights, the distance between the whale positions and the boats in figure 6 is only approximate. The recordings made on both flights contained oil exploration sounds similar to those previously described.

The recording made at the whale sighting position contained oil exploration sounds and also some low-frequency sounds that ranged from 30 to 130 Hz, with the maximum energy centered at 60 Hz. These sounds are shown in figure 7; parts A and B, respectively, show the oil exploration sounds with probable bowhead whale sounds and an isolated example of the probable bowhead whale sound.

## SUMMARY

Thirteen tapes considered to contain bowhead whale vocalizations of a quality suitable for analysis are listed in table 8. Preliminary analysis of the sounds indicates that bowhead whales vocalize at higher frequencies during the fall migration. In comparing the spring sounds to those of the fall, respectively, the average overall frequency range is 30 Hz to 2000 Hz and 30 Hz to 3500 Hz. A detailed report on the sound analysis of the bowhead whale for spring and fall 1979 is now being prepared.

Table 8. Dates and locations when recordings of probable bowhead whale vocalizations were collected.

| | | Location of recording |
|---|---|---|
| 24 Sept | Tape 1 | Demarcation Bay |
| 26 Sept | Tape 2 | Demarcation Bay |
| 26 Sept | Tape 3 | Demarcation Bay |
| 8 Oct | Tape 4 | Lease area, Block #1 |
| 11 Oct | Tape 5 | Lease area, Block #1 |
| 13 Oct | Tape 6 | Lease area, Block #1 |
| 14 Oct | Tape 7-8-9 | Lease area, Block #1 |
| 15 Oct | Tape 10 | Lease area, Block #1 |
| 16 Oct | Tape 11-12 | Lease area, Block #1 |
| 19 Oct | Tape 13-14 | Lease area, Block #1 and Northwest |

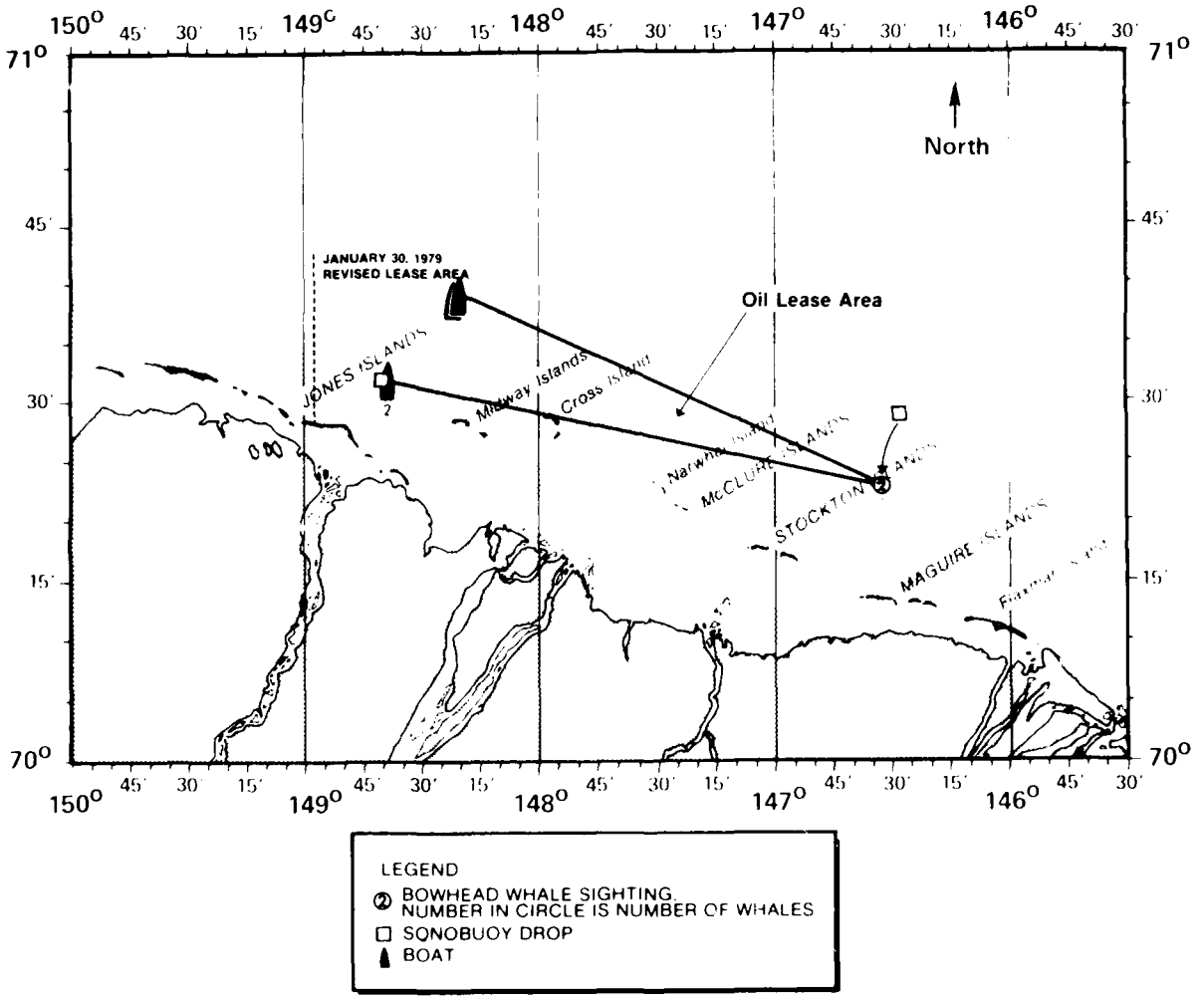
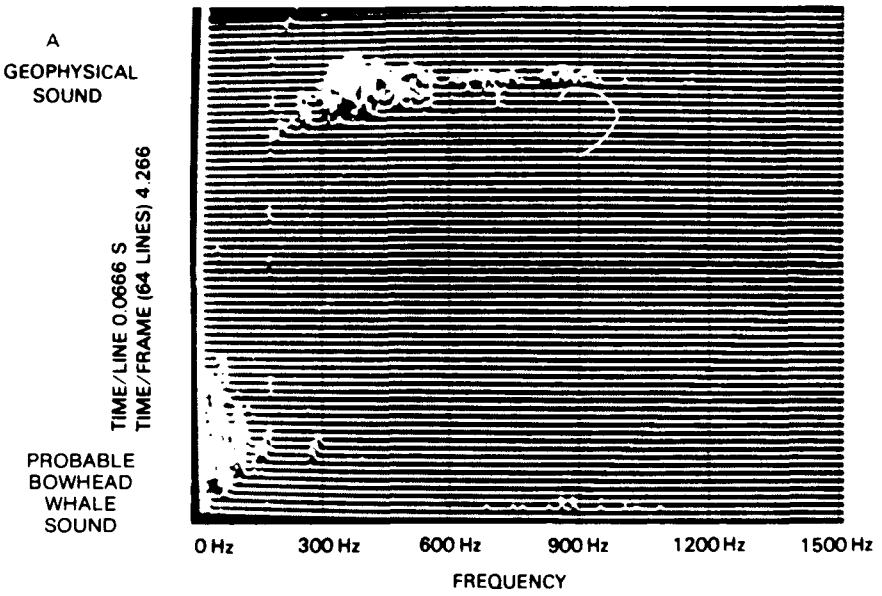



Figure 6. Flights 39-A and 40, 26 September 1979, detailing relative positions of geophysical sound sources, whale sighting, and sonobuoy drops.



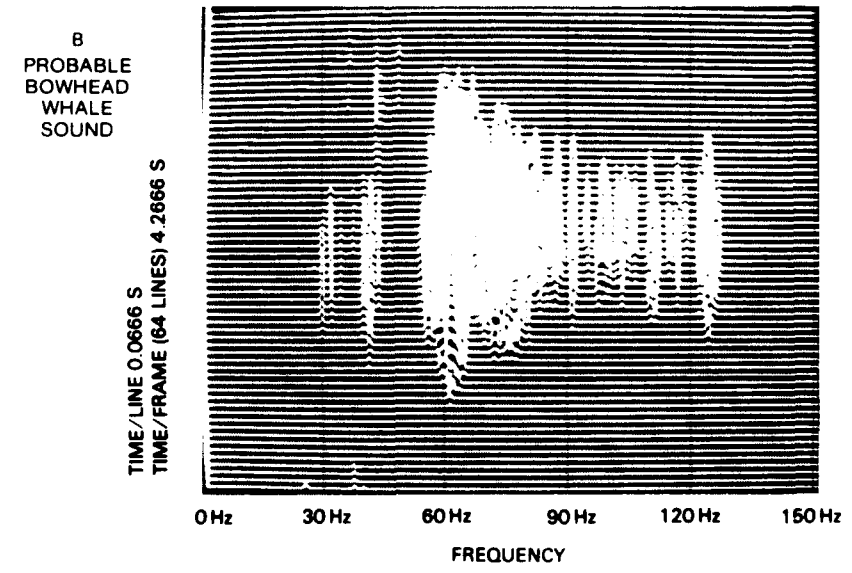




Figure 7. A) An example showing both geophysical and probable bowhead whale sounds. B) A probable bowhead whale sound shown in greater detail. The sounds detailed in both A and B were all recorded at 70°23′06″N, 146° 32′30″W, (flight 39-A, 26 September 1979), approximately 40 nautical miles from the source.

## DENSITY ESTIMATION

### METHODS

One approach for estimating the possible impact of oil production activities located offshore of Alaska's North Slope on the bowhead whale population would be to know the proportion of the population that occurs in or near the lease area. Density estimation of animal populations obtained by line transect methods can be useful when the counting of an entire population is not feasible. Burnham et al (1980) provide a comprehensive discussion of applied and theoretical aspects of density estimation by means of line transect data, including a nonparametric density estimator based upon the Fourier series (Crain et al, 1978), which is the one used in this report. Variances were calculated by using the "jackknife" technique (Burnham et al, 1980) for the variance of the density of groups and a formula from Seber (1973) for the variance of the density of individuals.

Data were collected by flying line transects consisting of a series of straight-leg segments and by surveying an area on both sides of the transect (figure 8). One half of the strip width (w), from the transect centerline out to either side, was chosen after the data were collected by taking the perpendicular distance of the farthest sighting. The clinometer angle and altitude were used for calculating the perpendicular distance from the sighting to the transect (figure 8). The aircraft's window design prevented a search directly below and the practical use of any clinometer angle greater than 70°. To compensate, all perpendicular distances and strip widths have been adjusted by subtracting a perpendicular distance from the transect's centerline, based on a clinometer angle of 70° and the aircraft altitude when a sighting occurred. This method assumes that no whales were seen in front of the aircraft in the excluded strip.

For density estimation, the necessary data for each sighting were: species identification, number of whales in the sighting, clinometer angle, altitude, and whether the plane was on a straight line transect or circling when the sighting occurred. Additional sightings made while the plane was circling to collect acoustic data were not used in a density estimate because they may not be independent sightings.

Line transect methods estimate density by using the formula, $\hat{D} = \frac{n\,\hat{f}_{(0)}}{2L}$ where n is the number of sightings, L is the length of the transect, and $\hat{f}_{(0)}$ is the evaluation at zero of probability density function f(x), which describes the probability of sighting an object at a given distance (x) from the transect line. To derive f(x), the observed perpendicular distances of the sightings are fitted to a "detection function," g(x).

Assumptions that must be met if the density estimate is to be unbiased are as follows:

1. Whales directly on the line, excluding the strip directly underneath the aircraft which cannot be seen, will never be missed; or, stated another way, the detection function at zero is always equal to one.

2. Whales are fixed at the initial sighting position; they do not move before being detected, and none is counted twice.

3. There are no measurement errors and no rounding errors; thus all data for the sighting are collected without error or bias.

4. Sightings are independent events.

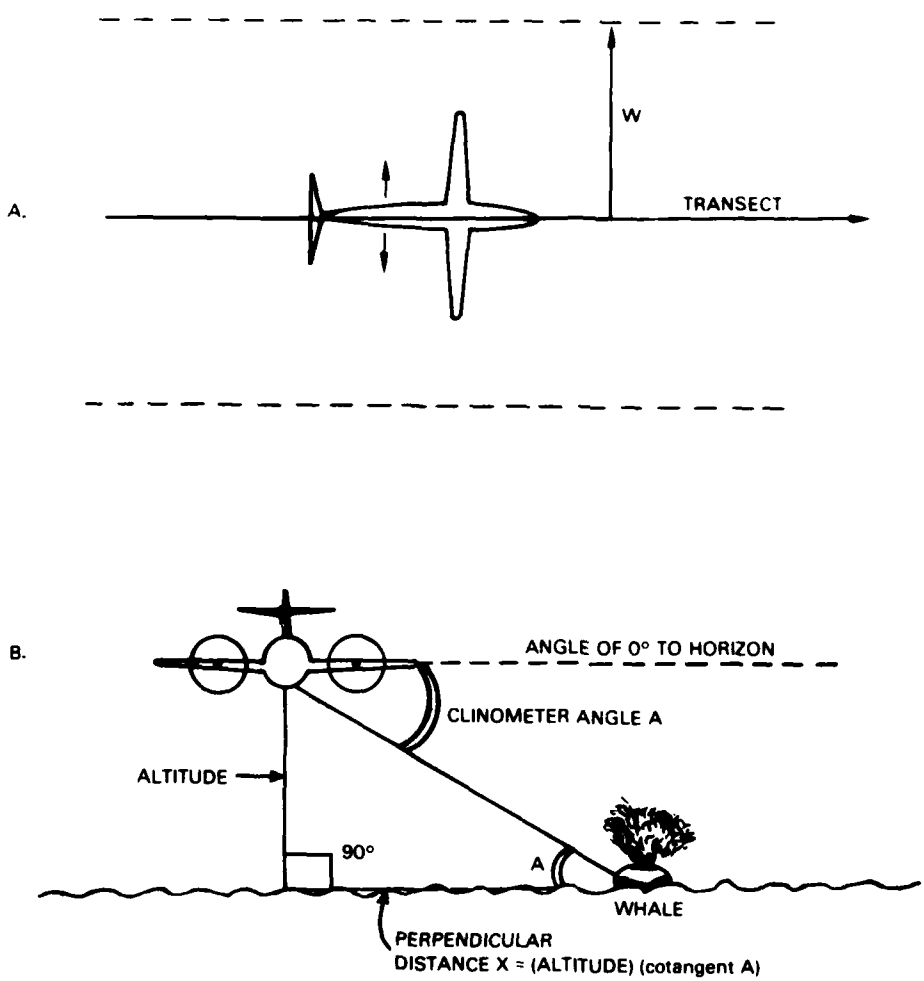



Figure 8. A) Diagram of an aircraft flying a line transect. B) Diagram showing the trigonometric relationships used to obtain the perpendicular distance X from clinometer angle A and aircraft's altitude.

Whales spend a large proportion of their time underwater and can dive rapidly; therefore, if a whale is on the transect but far enough underwater, it might be missed. This fact would bias the density estimate downwards. Bowhead whales move very slowly relative to an aircraft speed of 120 nmi/h, so that resighting became a possibility only when the aircraft was circling an area to collect acoustic recordings. Whenever the possibility of a resighting existed, the sightings were plotted on a chart, each one inside a circle based on an assumed average response speed of 1 nmi/h and the time between sightings. This estimated speed was based on a subjective impression of the average of all whale responses to the aircraft in the fall. If the circles touched or overlapped, all sightings in those circles after the initial one were considered to be possible repeat sightings. When sightings for the same transect plotted near enough geographically (usually within an area of approximately 2 $nmi^2$) to raise the suspicion that they were part of a group, they were then treated as such to retain independence of sightings. If these sightings had been made while the aircraft was on transect, the group's perpendicular distance was determined by drawing and measuring a perpendicular line from the visually obtained geometric center of the group back to the transect.

## RESULTS

Block #1 was the only area with enough whale sighting data to justify the calculation of a tentative density estimate. Only sightings made while on transect were used in the density estimate. Of the 64 bowhead whale sightings made in October (table 9), six sightings (9.4%) were judged to be repeat sightings and were not used in the density estimate. Only 24 (42%) of the remaining 57 original whale sightings were made while the aircraft was on a transect and not circling (table 10). Of these 24 sightings, three in Block #1 lacked perpendicular distances (table 11) and so could not be used in the Fourier series to obtain $\hat{f}_{(0)}$, which resulted in only 21 usable sightings. These sightings, plus the Block #1 sighting from 26 September, brought the total of usable sightings up to 22.

The calculated density estimates of groups and of individual whales are presented in table 12, along with other associated statistics such as 95% confidence limits. The Fourier series density estimator has been proven robust with regard to such sources of variability as differing altitudes, weather conditions, and observers (Crain et al, 1978). But even the best estimators are significantly affected by small sample size, and for better results a minimum sample size of 40 sightings is recommended (Crain et al, 1978).

The area of 4519.7 $km^2$, Block #1, for which this density estimate was calculated, is shown in figure 9. The whale sightings used to calculate the estimate are also plotted in figure 9. Detailed information on these sightings can be found in the tables in appendix B; only those sightings used will have a perpendicular distance listed in a column on the right side. The one sighting that lies just east of Block #1 (figure 9) occurred just after going back on transect, while returning from a prolonged circle for acoustic recording purposes that had begun midway through the last leg of flight 48, Block #1.

This preliminary, first-approximation density estimate applies only to the area within the heavy black line (figure 9), and only for the 21-day time period from 27 September to 17 October 1979. The density estimate is assumed to represent a 24-hour period. Multiplying the estimated density and its' 95% confidence limit times the total area used (4519.7 $km^2$) gives an estimated 835 whales/day, with an estimated range of from 293-1377 whales/day (table 13). The most likely straight-line route a whale might use to go through the area of Block #1 is 65 nmi long. Since all of the bowhead whales seen in fall 1979

| Month Flown | Oil Lease Block #1 Total / Orig / Rept | | | East (Block #3) Total / Orig / Rept | | | North (Block #2) Total / Orig / Rept | | | Northwest (Harrison Bay) Total / Orig / Rept | | | Demarcation Bay Total / Orig / Rept | | | West (Vicinity of Pt Barrow) Total / Orig / Rept | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| August | 0 | 0 | 0 | 4 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 |
| September | 1 | 1 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 75 | – | – | 0 | 0 | 0 |
| October | 64 | 58 | 6 | 1 | 1 | 0 | 14 | 9 | 5 | 19 | 15 | 4 | | | | 7 | 7 | 7 |

Table 9. Total original and repeat bowhead whale sightings by area and month for fall 1979. Demarcation Bay was only visited in September.

| Month Flown | Oil Lease (Block #1) Tran / Circle | | East (Block #3) Tran / Circle | | North (Block #2) Tran / Circle | | Northwest (Harrison Bay) Tran / Circle | | Demarcation Bay Tran / Circle | | West (Vicinity of Barrow) Tran / Circle | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| August | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | – | – | 0 | 0 |
| September | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | – | – | 0 | 0 |
| October | 24 | 34 | 1 | 0 | 5 | 4 | 2 | 13 | – | – | 7 | 0 |

Table 10. Total original bowhead whale sightings, by area and month for fall 1979, that were seen on transect or while circling. Demarcation Bay was only visited in September.

| Month | Oil Lease Block #1 PD | No PD | East Block #3 PD | No PD | North Block #2 PD | No PD | Northwest PD | No PD | Demarcation Bay PD | No PD | West PD | No PD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| August | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | | 0 | 0 |
| September | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 |
| October | 21 | 3 | 1 | 0 | 5 | 0 | 2 | 0 | | | 7 | 0 |

Table 11. Total original bowhead whale sightings seen on transect, Fall 1979, with sufficient data to be used to calculate a density estimate. Demarcation Bay was only visited in September. PD means perpendicular distance and No PD means that calculating a perpendicular distance was not possible.

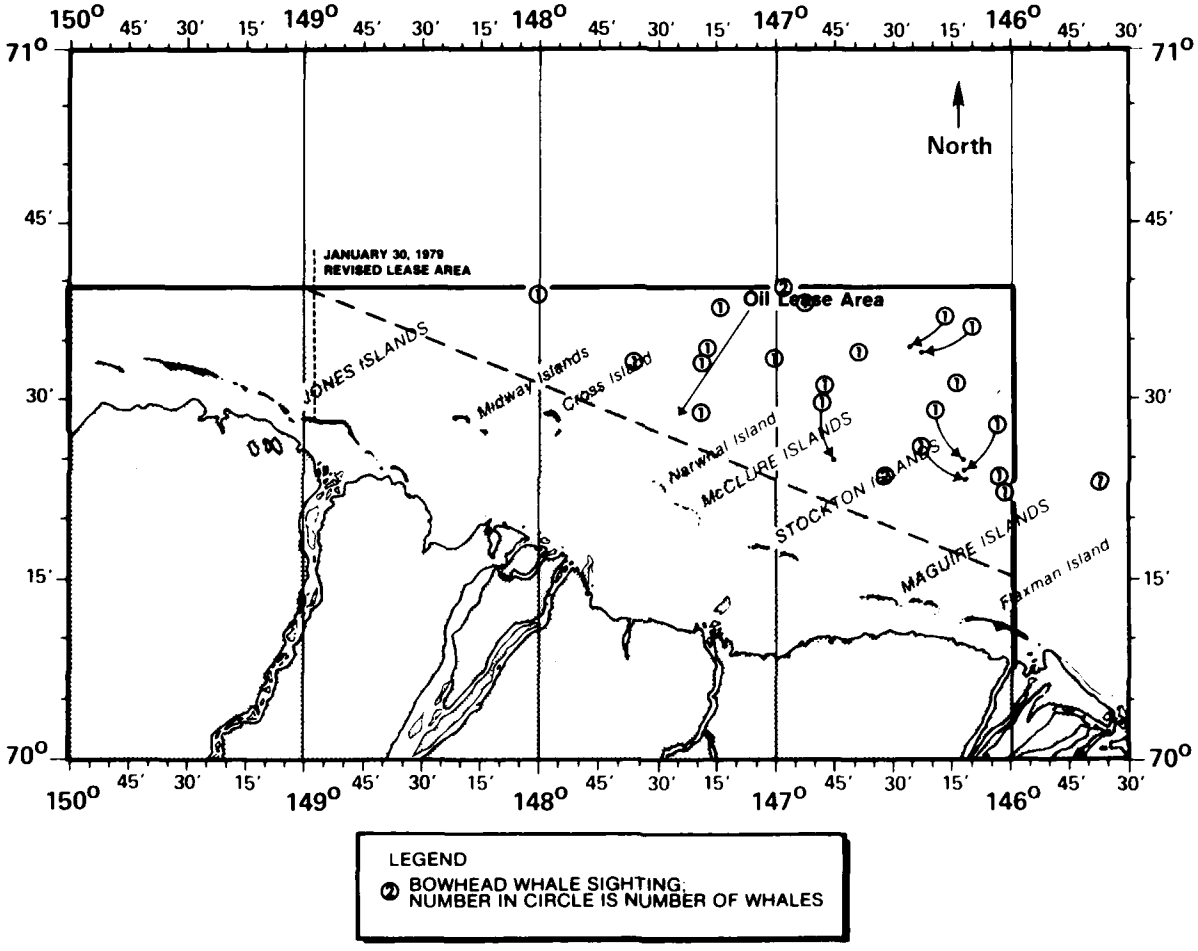



Figure 9. The heavy black line encloses the area of the bowhead whale sightings of 26 September and 8-17 October 1979 used in calculating the density estimate. The one sighting outside the line and to the east was made just after going back on transect when returning from a prolonged orbit for acoustic recording. This orbit started on the last leg of flight 48, Block #1. The dashed line represents the longest and most realistic straight line route that a migrating whale might take through Block #1.

| Statistics | Sightings Made Only on Transect in Block #1 | Sights Made Both on Transect and While Circling in Block #1 |
|---|---|---|
| n | 22 | 26 |
| Group Size X | 1.09 whales/group | 2.89 whales/group |
| Standard Deviation (SD) | 0.29 | 3.99 |
| Standard Error (SE) | 0.06 | 0.61 |
| Coefficient of Variation (%) | 5.7 | 27.2 |
| Density Estimate of Groups | 0.169 groups/$km^2$/day | |
| SE | 0.052 | |
| Coefficient of Variation (%) | 30.6 | |
| Density Estimate of Individuals | 0.183 whales/$km^2$/day | |
| SE | 0.058 | |
| Coefficient of Variation (%) | 31.2 | |
| Estimated Whales/Day (does not include effect of migratory speed) | 835 whales/day in Block #1 | |
| + 95% Confidence Limit (CL) | 542 | |
| Lower 95% CL | 293 | |
| Upper 95% CL | 1377 | |

Table 12. Mean group size and density estimates based upon the Fourier series, along with associated 95% confidence limits and population estimates, are presented for sightings made only on transect. Mean group size and associated statistics for sightings made both on transect and while circling are shown, although they were not used in calculating density or population estimates. Both density and population estimates are based upon small sample sizes and are only preliminary, first approximation estimates.

appeared to be moving quite slowly and behaving differently as compared with those seen in spring, the estimated total number of whales migrating through the area was calculated for both different estimated migratory speeds (ranging from 0.10 to 1.00 nmi/h) and different (maximum and minimum) periods of peak migration (table 14 and figure 10). These are only a first approximation for obtaining an accurate estimate of whales migrating through the area. In addition, table 14 figures may be severely biased downwards if the indication that mean group size (table 12) should be larger than 1.09 whales is true.

| Statistics | Sightings Made Only on Transect |
|---|---|
| n | 22 |
| Group Size X | 1.09 whales/group |
| SD | 0.29 |
| SE | 0.06 |
| Coefficient of Variation (%) | 5.7 |
| Density Estimate of Groups | 0.169 groups/km$^2$/day |
| SE | 0.052 |
| Coefficient of Variation (%) | 30.6 |
| Density Estimate of Individuals | 0.185 whales/km$^2$/day |
| SE | 0.058 |
| Coefficient of Variation (%) | 31.2 |
| Estimated Whales/Day | 835 whales/day in Block #1 |
| ±95% CL | 542 |
| Lower 95% CL | 293 |
| Upper 95% CL | 1377 |

Table 13. Mean group sizes; density estimates based upon the Fourier series, along with associated 95% confidence limits and population estimates, are presented for sightings made only on transect.

## SUMMARY

Although the larger mean group size was not used in calculating the density estimate of individual whales because it was based primarily on sightings made off transect, it points to the clear possibility that bowhead whales aggregate in loosely associated groups in the fall. Observations show that the size of these groups cannot be accurately assessed while on transect, which suggests that a standard circling procedure that results in analyzable data should be designed and implemented.

As a result of bad weather during the last 4 days of September and the lack of an aircraft during the first week of October, the beginning date of peak migration is not known but is estimated to be within an 11-day period. Peak migration could have begun as early as 27 September or as late as 7 October 1979, and did continue until 17 October 1979. It is hoped that a better assessment of the timing of peak migration can be obtained during fall 1980.

Estimated Total Whales for Peak Migration,
Minimum Migratory Period of 11 Days
(7 October to 17 October 1979)

| Speed nmi/h | Lower 95% CL | Point Estimate | Upper 95% CL |
|---|---|---|---|
| 0.10 | 120 | 342 | 565 |
| 0.25 | 299 | 852 | 1405 |
| 0.50 | 595 | 1695 | 2795 |
| 0.75 | 894 | 2547 | 4200 |
| 1.00 | 1190 | 3390 | 5591 |

Estimated Total Whales for Peak Migration,
Maximum Migratory Period of 21 Days
(27 September to 17 October 1979)

| Speed nmi/h | Lower 95% CL | Point Estimate | Upper 95% CL |
|---|---|---|---|
| 0.10 | 229 | 651 | 1074 |
| 0.25 | 568 | 1620 | 2671 |
| 0.50 | 1134 | 3231 | 5329 |
| 0.75 | 1705 | 4860 | 8014 |
| 1.00 | 2271 | 6471 | 10672 |

Table 14. The estimated total numbers of bowhead whales that migrated through Block #1 in the fall of 1979 are calculated for both the minimum and maximum possible periods of peak migration by using different assumed migratory speeds. These estimates are only preliminary approximations, and were calculated specifically to illustrate the urgent need for sound data about migratory speed and behavior.

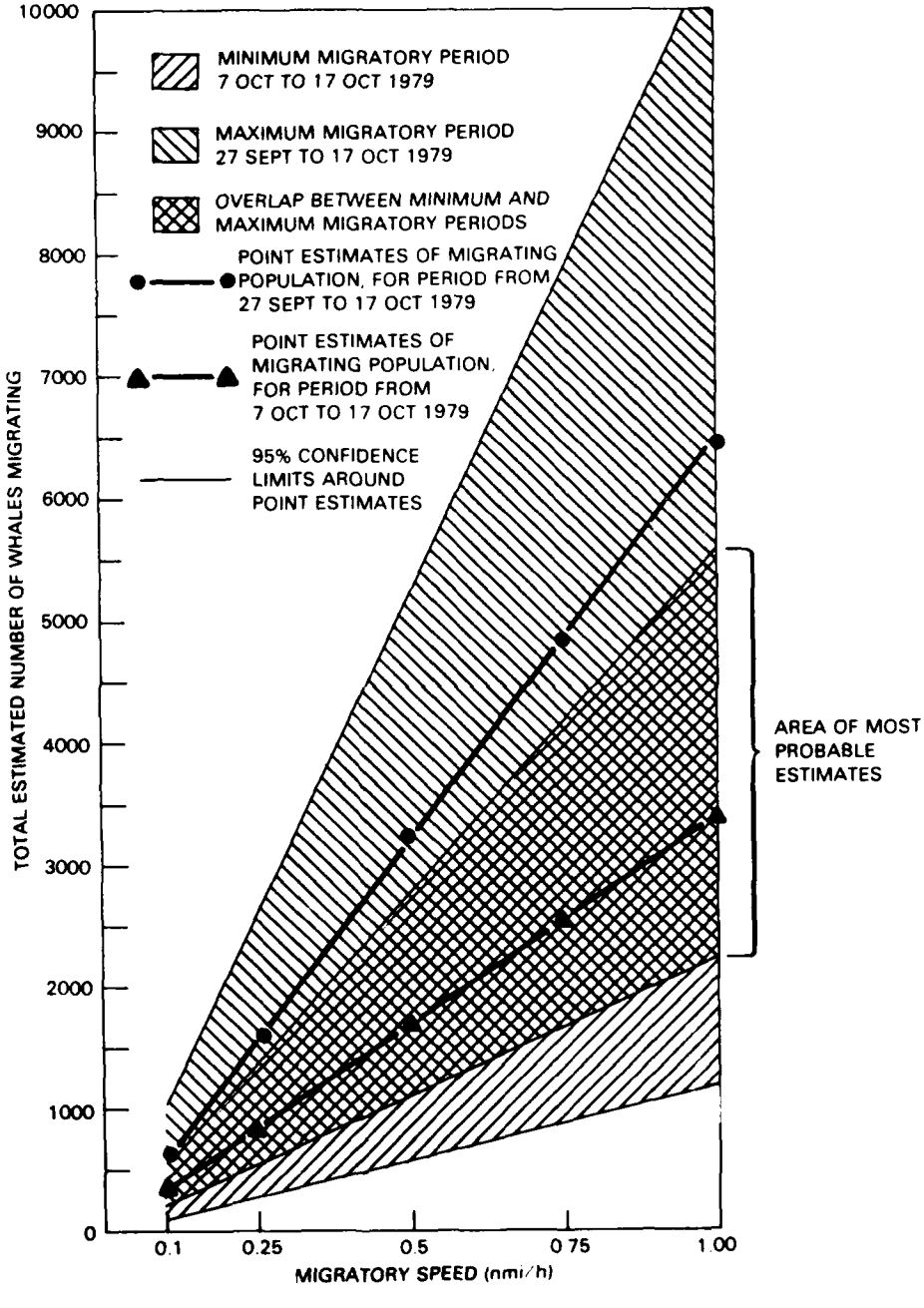



Figure 10. The total estimated number of Bowhead whales, bounded by 95% confidence limits, for both the minimum and maximum possible period of peak migration, increases sharply with an increase in assumed migratory speed. These estimates are only first approximations and were calculated specifically to illustrate the urgent need for sound data about migratory speed and behavior.

Until a comprehensive tagging program, preferably with radio tags, has been conducted, the very important question of how fast whales are migrating through a specific area, such as Block #1, cannot be completely answered. The speed and consistency with which a whale migrates in the fall are important assumptions for first obtaining a density estimate and then converting it into an estimated number of whales that migrated through an area. Assessing the accuracy of estimates of migrating whales is impossible until more information about migratory behavior and speed has been obtained. The precision of such estimates can be improved by use of a larger sample size and more exact knowledge about the time period of peak migration, which would allow more uniform sampling of peak migration.

## OVERALL DISCUSSION

As increased levels of oil exploration and oil-related operations are undertaken in areas which may be in the migratory path of the bowhead whale and other marine mammals, a better understanding of the potential impact of these operations is necessary. The study of behavior patterns, vocalizations, main areas of concentrations, number of animals, and possible feeding areas can be undertaken by means of aerial survey techniques.

The surveys conducted in 1979 in and about the Beaufort sea oil lease area defined the timing of the 1979 fall migration. It also gave us a sighting figure of 249 bowhead whales, of which six whales were inside the lease area, with the majority north of the lease area. The number of sightings which occurred along the 10-fathom line was significant and it should be tentatively considered as an area of concentration, along with Demarcation Bay.

The behavior of the whales observed at Demarcation Bay and west along the 10-fathom line to Harrison Bay was different from that of whales steadily migrating in a predominantly westward direction. On numerous occasions, individuals and groups of whales were observed lying still, milling, diving, and heading in different directions. Once the whales were past Harrison Bay, their headings stabilized and became more westerly.

The use of randomly dropped sonobuoys to detect accurately the presence of bowhead whales was not successful. Sounds recorded during these drops were mostly ring seal or oil exploration sounds.

Drops made in the presence of fall whales were successful in recording vocalizations approximately 50% of the time. This rate is considerably higher than the success rate achieved in the spring of 20% and supports the contention that whales were more vocal in the fall than in spring.

The interpretation of the behaviors and relative speeds observed during the fall surveys has a direct effect on the density estimate. Although no significant westerly movement could be verified on a daily basis in Block #1, it was necessary to assume a generally westward heading for purposes of the density estimate. The fall swimming speeds were estimated to be 1.0 knot or less, considerably slower than the estimated speeds during spring (3 knots). The main indicator of differences in speed between the spring and the fall was the absence of the whale "track" in the fall. Tracks which indicate a faster-moving whale were evident on most sightings in the spring. Of the 90 sightings made in Block #1, 68 were made when circling the area of the initial line transect sighting. From these sightings a mean overall group size of 3.52 whales was calculated for the 32 groups seen. The groups ranged in size from one to 21 whales.

The aerial surveys were conducted to estimate populations of migrating bowhead whales through Block #1, which includes the oil lease area. The preliminary density estimate is based on a series of untested assumptions (including an assumed swimming speed of 1 knot) and 22 verified on-track sightings. Overall analysis produces a population estimate (with 95% confidence limits) of 835 whales/day ± 540 whales/day. These figures should be considered preliminary because of the small sample size of 22 sightings and the still untested assumptions of whale migratory and speed behavior.

## CONCLUSIONS

The following tentative conslusions are made based on the spring, summer, and fall 1979 study.

1. Bowhead whales do not migrate through or inhabit the lease area during the spring migration. In the fall, the lease area is icebound and it is known that bowhead whales use offshore lead systems as migration routes.

2. No bowhead whales were seen in or about the lease area during the summer (June-July). In the summer, bowhead whales have generally completed the eastward migration to the Banks Island area and it is known that a portion of the population spends the summer in the Canadian Beaufort Sea.

3. During the fall migration, a total of 6 bowhead whales was observed in the lease area and 84 bowhead whales were seen near the lease area. It was noted that bowheads generally tend to migrate along the 10-fathom/20-meter line during the westward migration. The significance of the 10-fathom/20-meter line as a migration route is not known at this time.

4. Bowheads vocalize in a frequency band of 30 Hz to 2000 Hz in the spring and in a frequency band of 30 Hz to 3500 Hz in the fall.

5. Bowheads were disturbed by the aircraft in the spring but not in the fall.

6. Bowheads migrate at a slower speed in the fall than in the spring.

## RECOMMENDATIONS

1. To determine whether the whales seen near the 10-fathom curve are the majority of migrating whales in this area, flights should be alternated inshore and offshore during next season's peak periods of migration.

2. The precision of the density estimate and derived number of whales migrating through Block #1 should be improved by placing more emphasis on line transect observations and less on acoustic recordings. More accurately identifying the period of peak migration within a given year also will help improve the estimate. A comprehensive radio tagging program is highly recommended as the best way to provide information on assumptions (such as the speed and consistency with which bowhead whales migrate in fall), which are essential to estimating the number of migrating whales. Migratory speed directly affects the probability of resighting whales between transects, or between survey days.

3. The observations made in the area of Demarcation Bay suggest the presence of a whale feeding ground. These observations, when coupled with the fact that stomach contents were found in several whales taken at Kaktovik in the fall, indicate a feeding area

relatively close and probably east of where they were taken. Demarcation Bay fits these criteria and would be a prime area for further investigations.

4. Geophysical and other oil exploration-related sounds should be studied further to determine whether they have any interaction on the bowhead whale and other marine mammals common to these areas.

## VIII. REFERENCES


1. Batschelet, Edward. 1972. Recent statistical methods for orientation data. Pages 61-91 in S.R. Galler, K. Schmidt-Koenig, G.J. Jacobs, and R.E. Belleville, eds. Animal orientation and navigation. Scientific and Technical Information Office, National Aeronautics and Space Administration, Washington, DC.

2. Braham, H., B. Krogman, Stephen Leatherwood, W. Marquette, D. Rough, M. Tillman, J. Johnson, and G. Carroll. Preliminary report of 1978 spring bowhead whale research program results paper presented at the annual meeting of the International Whaling Congress, Scientific Advisory Committee, London, June 12-20 1978.

3. Burnham, K.P., D.R. Anderson, and J.L. Laake. 1980. Estimation of density from line transect sampling of biological populations. Wildlife Monograph, in preparation.

4. Crain, B.R., K.P. Burnham, D.R. Anderson, and J.L. Laake, 1978. A Fourier series estimator of population density for line transect sampling. Utah State University Press. 25 p.

5. Leatherwood, S. 1979. Development of standardized procedures for aerial surveys of cetaceans. A contract report to National Marine Fisheries Survey, St Petersburg, Florida. HSWRI. 132 p.

6. Ljungblad, D.K. 1979. Spring final report investigation of the occurrence, population density, and behavior patterns of endangered whales in the vicinity of the Beaufort Sea lease areas. Submitted to US Department of Interior Bureau of Land Management, 800 A Street, Anchorage, Alaska.

7. Ljungblad, D.K., S. Leatherwood, M.E. Dahlheim. 1979. Sounds recorded in the presence of an adult and calf bowhead whale.

8. Ljungblad, D.K., M.F. Platter-Rieger. 1979. Interim report BLM whales summer-fall. Submitted to US Department of Interior Bureau of Land Management, 800 A Street, Anchorage, Alaska 99501.

9. Seber, G.A.F. 1973. The estimation of animal abundance. Hafner, New York.

## APPENDIX A

### SHORT HISTORY AND SELECTED BIBLIOGRAPHY OF THE BOWHEAD WHALE, *Balaena mysticetus*, DRAWN LARGELY FROM LEATHERWOOD AND REEVES (1980).

Bowhead whales, *Balaena mysticetus*, Linnaeus, 1758 (also referred to in the literature as Greenland whale, arctic right whale, and great polar whale) are large baleen whales found circumpolar in the Arctic (Mitchell, 1976). Five separate stocks are thought to exist in the Sea of Okhotosk; the Bering, Chukchi, and Beaufort Seas; Baffin Bay and Davis Strait and their adjacent waters; Hudson Bay; and the Greenland and Barents Seas. The last-mentioned stock is very near extinction. The Hudson Bay and Sea of Okhotosk stocks may be stable but at relict levels of abundance (100 or less). In Baffin Bay and Davis Strait there are at least a few hundred left, and they could be increasing slowly. The only substantial population is that in the Bering, Chukchi, and Beaufort Seas.

Commercial exploitation of this population began in the Bering, Chukchi, and later Beaufort Seas during the mid-1800's. The last reported voyage occurred in 1916 when the steamer HERMAN and the auxiliary whaling schooner BELVEDERE sailed north in the spring from San Francisco and Seattle, respectively, returning that autumn with some whale products. Some of the Arctic Alaskan trading companies continued to deal in whalebone for a few more years into the early 1920s. But bowheads have been completely protected from commercial whaling by the International Convention for the Regulation of Whaling since 1946 and, subsequently, by the US Marine Mammal Protection Act (MMPA) of 1972 and the US Endangered Species Act (ESA) of 1973. However, aboriginal whaling continues at a level which has been increasing in recent years. This harvest is the subject of much debate and legal conflicts between eskimos and individuals or institutions attempting to stop or regulate this whaling.

Though once much more abundant (perhaps from 18,000 to 36,000 in 1842) and more wide-ranging (with catches as far southeast as the Pribilof Islands), the estimated 1000 to 3000 remaining bowheads in the Western Arctic population apparently winter in the southwestern Bering Sea along and south of the pack ice edge and in polynyas within the ice.

In early spring, whales from this population move northward from the Bering Sea, passing St Lawrence and Diomede Islands, primarily on their western sides, in three or four pulses or waves of abundance. Most turn northeastward in the Chukchi Sea, following the most inshore leads or cracks in the ice, round Point Barrow in April, and continue along the leads to Banks Island and Prince Albert Island. As the ice recedes in summer, they spread south and east, at least into Amundsen Gulf. As ice begins to re-form and advance in the fall, they move westward (most apparently moving close outside the 10-fathom line and/or along the ice edge), some reaching the northeast Soviet coast near Wrangel Island before yielding to the winter ice by moving gradually southward to favored wintering grounds.

Although bowheads are migratory, their behavior in this regard seems to depend entirely on ice formation and movement. Whaling records suggest that bowheads are segregated to some extent by age and sex during migrations. All populations that have been studied winter near the southern limits of pack ice.

This is a slow-moving whale (average maximum speed of 3 knots/h or less). It reportedly can remain underwater for periods of over 40 minutes, but is not regarded as a deep diver. Traveling bowheads often raise their flukes on the last dive of a series. Animals have been observed to hang vertically in the water with their heads exposed, and tail-lobbing and flipper-slapping are seen occasionally.

Bowheads are not gregarious, and usually travel alone or in small groups. Concentrations of up to 50 whales have been reported on suspected feeding grounds.

The bowhead's life history is poorly understood. Females probably calve at intervals of at least 2 years, and calves are reportedly born in the spring. Calves have been seen in May in the Bering Sea and in October in the Beaufort Sea. The percentage of calves observed to date is low, between 1 and 2% of the total population. Bowheads feed primarily on swarms of small- to medium-sized zooplankton euphausiids, amphipods, copepods, mysids, and pteropods (Lowrey and Burns). While basically "skimmers," they do forage very near the bottom, at least in shallow areas, and have been seen surfacing at the edge of a mud boil of their own making with mud and detritus streaming from the mouth.

The only suspected natural predator is the killer whale. Starvation from lack of access to feeding areas and suffocation under ice are other suspected natural causes of death.

## SELECTED BIBLIOGRAPHY ON BOWHEAD WHALES


Alaska Environmental and Information Data Center.
Map 27. Biota. Distribution and migration of important whales. Series Chukchi Sea: Bering Strait – Icy Cape. Physical and biological character of Alaskan coastal zone and marine environment. AEIDC, Anchorage, AK.

Alen, G.M. 1942. Extinct and vanishing mammals of the western hemisphere with the marine species of all the oceans. Amer. Comm. Internat. Wildl. Protection, spec. pub. No. 11: 620 p.

Anon. 1977. White whale offshore exploration acoustic study. E.E. Slaney and Co. Ltd., Vancouver, B.C.

Bailey, A.M., and R.W. Hendee. 1926. Notes on the mammals of northwestern Alaska. J. Mammal. 7(1): 9-28.

Bee, J.W., and E.R. Hall. 1956. Mammals of northern Alaska on the Arctic Slope. Univ. of Kansas, Museum of Natural History, misc. pub. No. 8: 309 p.

Berzin, A.A., and A.A. Rovnin. 1966. Raspredelenie i migratsii kitov v severovostochnoi chasti Tikhogo okeana, v Beringovom i Chukotskom moyakh (Distribution and migration of whales in the northeastern part of the Pacific Ocean, Bering, and Chuckchee Seas). Izv. Tikhookean. Nauchno-issled. Inst. Morsk. Rybn. Khoz. *Okeanogr.* 58:179-207. In Russian. (Transl. by Dep. Int., Bur. Commer. Fish., Seattle, Washington, 1966, in K.I. Panin (ed.), Soviet Research on Marine Mammals of the Far East, p. 103-136).

Berzin, A.A. 1959. Search of whales – Promyshelnnost Primorya, 9.

Bockstoce, J.R. 1977. Steam whaling in the western Arctic. New Bedford Whaling Museum, Old Dartmouth Historical Society, New Bedford, MA, 127 p.

Bodfish, H.H. 1936. Chasing the bowhead whale. Harvard Univ. Press, Cambridge, MA, 281 p.

Braham, H.W., B. Krogman, and C.H. Fiscus. 1977. Bowhead, ***Balaena mysticetus***, and Beluga, ***Delphinapterus leucas***, whales in the Bering, Chukchi and Beaufort Seas. Report NMFS NWAK, Seattle, WA.

Braham, H.W., C.H. Fiscus, and D.J. Rugh. 1977. Marine mammals of the Bering and southern Chukchi Seas. Annual OCSEAP Report, April 1976-March 1977, research unit 67, 92 p.

Braham, H.W., B. Krogman, S. Leatherwood, W. Marquette, D. Rugh, M. Tillman, J. Johnson, and G. Carroll. 1978. Preliminary report of spring 1978 bowhead whale research program results report NMFS NW AK. Seattle, WA.

Braham H., B. Krogman, W. Marquette, D. Rugh, J. Johnson, M. Nerini, S. Leatherwood, M. Dahlheim, R. Sonntag, G. Carroll, T. Bray, S. Savage, and J. Cubbage. 1978. Bowhead whale ***(Balaena mysticetus)*** preliminary research results, June through December 1978. Report NMFS NWAK Seattle WA.

Braham, H.S., Marquette, W. and Leatherwood, S., editors. Marine Fisheries Review. Special issue on the bowhead whale. Mar 1980 (in press). Note: This issue includes 16 original articles not listed here, and should be consulted for details.

Brower, C.D. Fifty years below zero. Dodd, Mead and Co., N.Y., 310 p.

Brownell, R.L., Jr. 1971. Whales, dolphins and oil pollution. pp. 255-276. In: Ecological and oceanographic survey of the Santa Barbara Channel oil spill 1969-1970. Vol. I. Allan Hancock Foundation, University of Southern California.

Carroll, B.M. 1976. Utilization of the bowhead whale. Marine Fisheries Review, 38(8): 18-21.

Clark, A.H. 1887. The whale-fishery. History and present condition of the fishery. *In:* Goode, G.B., The fisheries and fishery industries of the United States, sec. 5, vol. 2, p. 1-218.

Cook, J.A. 1926. Pursuing the whale: a quarter century of whaling in the Arctic. Houghton Mifflin Co., Boston and New York, 344 p.

Dall, W.H. 1899. How long a whale may carry harpoon. Nat. Geogr., 10(4): 136-137.

Dawbin, W.H. 1966. The seasonal migration of humpback whales. pp. 145-170. *In:* K.S Norris (ed.). Whales, dolphins, and porpoises. Univ. Calif. Press, Berkeley and Los Angeles.

Draft Environmental Impact Statement. 1976. Consideration of a waiver of the moratorium and return of management of certain marine mammals to the State of Alaska. Volume I — summary and text. Interagency Task Group, U.S. Dep. Commer., NOAA, and U.S. Dep. Interior, Fish and Wildlife Serv., 155 p.

Durham, F.E. 1972. History of bowhead whaling and the Greenland or bowhead whale. U.S. Govt. Rep. No. AD-759 592 NTIS. 13 p.

Durham, F.E. 1974. Ancient and current methods of taking the bowhead whale. Univ. of Alaska Sea Grant Program, Anchorage, Alaska, Sea Grant Report 73-9, 15 p.

Durham, F.E. 1975. The catch of bowhead whales *(Balaena mysticetus)* by Eskimos in the western Arctic. Unpubl. manuscr., 18 p.

Durham, F.E. 1974. Recent and current methods of taking the bowhead whale. University of Alaska Sea Grant Program, Anchorage, AK, Sea Grant Report 73-9, p. 15.

Durham, Floyd E. 1972. Biology of the bowhead whale ***Balaena mysticetus*** in the eastern Arctic. University of Southern California, Los Angeles, unpublished.

Durham, Floyd E. 1973. Census and spring migration studies on the bowhead whale in the western Arctic in 1973. U.S. Department of Commerce, NOAA. NMFS, unpublished.

Eschricht, D.F. and T. Reinhardt. 1866. On the Greenland right whale ***(Balaena mysticetus).*** 150 p. *In:* W.H. Flower. Recent memories on the cetacea, Royal Soc., London.

Fay, F.H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea. *In:* Oceanography of the Bering Sea with emphasis on renewable resources, ed. by D.W. Hood and E.J. Kelley, Internat. Sympo. for Bering Sea Study, Occas. pub. no. 2, chap. 19: 383-399.

Fay, F.J. 1975. Mammals and birds. *In:* Bering Sea oceanography: an update 1972-74, ed by D.W. Hood and Y. Takenouti, Instit. Mar. Sci., Univ. of Alaska, Fairbanks. Report no. 75-2: 133-138.

Fiscus, C.H., and H.W. Braham. 1976. Distribution and abundance of bowhead and belukha whales in the Beaufort and Chukchi Seas. Fifth quarterly OCSEAP report, research unit 70, p. 36-42. *In:* Environmental assessment of the Alaskan continental shelf, principal investigators' reports, vol. I, July-September.

Fiscus, C.H., W.M. Marquette, and H.W. Braham. 1976. Abundance and seasonal distribution of bowhead whales and beluga. Report Research Unit No. 70. NOAA, NMFS 15 May, 1976.

Fiscus, C.H., H.W. Braham, and W.M. Marquette. 1976. Distribution and abundance of bowhead and beluga whales in the Beaufort and Chukchi Seas. Fourth quarterly OCSEAP report, Research Unit 70, pp. 68-84. *In:* Environmental assessment of the Alaskan continental shelf, principal investigators' reports, vol. I, April-June.

Fiscus, C.H., and W.M. Marquette. 1975. National Marine Fisheries field studies relating to the bowhead whale harvest in Alaska, 1974. Processed Rep., U.S. Dep. Commer., Nat'l Mar. Fish. Serv., Seattle, WA, 23 p.

Fiscus, Clifford H., and William M. Marquette. 1974. NMFS field studies relating to the bowhead whale harvest in Alaska. National Marine Fisheries Center Processed Report, Jan. 1975.

Fleischer, G. 1976. Über die Verankerung des Stapes im Ohr Der Cetacea und Sirenia. Zeit. Saugetierkunde 41: 304-317; Verlag Paul Parey, Hamburg und Berlin.

Foote, D.C. 1964. Observations of the bowhead whale at Pt. Hope, Alaska. Unpubl. Manuscr., 70 p.

Fraker, M.A. 1977. The 1976 white whale monitoring program, Mackenzie Estuary, NWT Imperial Oil Ltd., F.F. Slaney & Co., Ltd., Vancouver, B.C., 73 p.

Harmer, S.F. 1928. The history of whaling. Proc. Linn. Soc., London. Sess. 140, 1927-2 p 51-95.

Hegarty, R.B. 1959. Return of whaling vessels sailing from American ports. A contribution of Alexander Starbuck's "history of the American whale fishery." Old Dartmouth Historical Society, New Bedford, MA, 58 p.

Johnson, M.L., C.J. Fiscus, B.T. Ostenson, and M.L. Barbour. 1966. Marine mammals *In:* N.J. Wilimovsky and J.N. Wolfe (eds.), Environment of the Cape Thompson region, Alaska, pp. 877-923. U.S. Atomic Energy Comm., rep. PNE-41.

Kleinenberg, S.E., A.V. Yablokov, B.M. Bel'Kovich, and M.N. Tarasevich. 1964. Belukha. Opyt monographicheskogo issledovaniya vida [Beluga (Delphinapterus leucas): investigation of the species]. Izd. "Nauka," Moscow. In Russian (transl. by Israel Program Sci. Transl., 1969, 376 p.).

Klumov, S.K. 1956. Some results of an expedition to the Bering Sea and Kuril Islands. Vestnic AN SSSR, 5.

Leatherwood, S., W.F. Evans, and D.W. Rice. 1972. The whales, dolphins, and porpoises of the eastern North Pacific: a guide to their identification in the water. Naval Undersea Center, San Diego, CA 92152. Technical paper 282.

Leatherwood, S., D.K. Caldwell, and H.E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic: a guide to their identification. NOAA technical report NMFS CIRC 396.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1980. The whales, dolphins, and porpoises of the eastern North Pacific: a guide to their identification. NOAA Technical Report NMFS CIRC (in press).

Leatherwood, S., and R. Reeves. 1980 (in press). Cetaceans and Sirenians of the world: whales, dolphins, and porpoises; manatees, dugongs, and sea cows; Sausalito, Painter Hopkins Publishers, 307 p.

LeResche, R.E., and R.A. Hinman. 1973. Alaska's wildlife and habitat. Alaska Dep. Fish Game, 144 p.

Ljungblad, D., S. Leatherwood, and D. Dahlheim. 1980. Sounds recorded in the presence of an adult and calf bowhead whale *(Balaena mysticetus).* Marine Fisheries Review special issue on the bowhead whale (in press).

Maher, W.J., and N.J. Wilimovsky. 1963. Annual catch of bowhead whales by Eskimos at Point Barrow, Alaska, 1928-1960. J. Mammal. 44(1):16-20.

Mansfield, A.W. 1971. Occurrence of the bowhead or Greenland right whale *(Balaena mysticetus)* in Canadian Arctic waters. J. Fish. Res. Bd. Canada 28(12): 1873-1875.

Marquette, W.M. 1976. Bowhead whale field studies in Alaska, 1975. Mar. Fish. Rev. 38(8): 9-17.

Marquette, W.M. The 1976 catch of bowhead whales *(Balaena mysticetus)* by Alaskan Eskimos. With a review of the fisheries 1973-1976, and a biological summary of the species. N.W. Alaska Fisheries Center Processed Report.

McVay, S. 1973. Stalking the arctic whale. Amer. Sci., 61(1):23-37.

Mitchell, E. 1974. Trophic relationships and competition for food in northwest Atlantic whales. *In:* Proc. Canadian Soc. Ann. Zool. Meet., ed. by M.D.B. Burt, Univ. of New Brunswick, Frederiction, 2-5 June, pp. 123-33. Submitted to Sci. Comm., Internat. Whaling Comm., June 1974, London, Doc. SC/26/35.

Mitchell, E. 1974. Present status of northwest Atlantic fin and other whale stocks. *In:* The whale problem, W.E. Schevill (ed.), Harvard Univ. Press, Cambridge, MA, chap. 5, pp. 108-169.

Nelson, R.K. 1969. Hunters of the northern ice. University of Chicago Press, Chicago, Ill. 429 p.

Nikulin, P.G. 1946. On the distribution of whales in the seas around the Chukchi peninsula. Izvestia tichookeanskogo instituta rybnogo khozyaystva, vol. 22.

Nordman, F.D. 1974. Russian whaler in the Okhotsk Sea. Izvestia Russkogo geograficheskogo obschestva, v. 10, 2.

Nordman, F.D. 1975. Whale hunting near Shantar islands and the shore of the Okhotsk Sea, 1868-1874. Norskoy sbornik, II.

Oswalt, W.H. 1967. Alaskan Eskimos. Chandler Pub. Co., San Francisco, California, 297 p.

Rice, D.W. 1974. Whales and whale research in the eastern North Pacific. *In:* W.E. Schevill (ed.), The whale problem, pp. 170-195. Harvard Univ. Press, Cambridge, MA.

Sergeant, D.E. and W. Hoeh. 1974. Biology of bowhead ***Balaena mysticetus*** and white whale ***Delphinapterus leucas*** in the Beaufort Sea. Interior Department of Beaufort Sea project study A4.

Scammon, C.M. 1874. The marine mammals of the northwestern coast of North America, together with an account of the American whale fishery. John M. Cammany and Co., San Francisco, 319 p.

Scoresby Jr., W. 1820. An account of the Arctic regions, with a history and description of the northern whale fishery. Archibald Constable and Co., Edinburgh, 2 vols., 551 p.

Scoresby Jr., W. 1823. Northern whale-fishery. A. Constable and Co., Edinburgh; and Hurst, Robinson and Co., Cheapside, London, 472 p.

Sleptsov, M.M. 1961. Okolebanii chislennosti kitov v Chukotskom more v, raznye gody. (Fluctuations in the number of whales of the Chukchi sea in various years). Trudy Instututa Morfologii Zhivotnykj, vol. 34, pp. 54-64; translation No. 478, U.S. Naval Oceanographic Office, Washington, D.C., 1970.

Slijper, E.J. 1962. Whales. Hutchinson and Co., London. 475 p.

Sonnenfeld, J. 1960. Changes in an Eskimo hunting technology, and introduction to implement geography. Annals Assoc. Amer. Geogr., 50(2):172-186.

Starbuck, A. 1964. History of the American whale fishery, from its earliest inception to the year 1876. Argosy-Antiquarian Ltd., New York, 779 pp.

Townsend, C.M. 1935. The distribution of certain whales as shown by logbook records of American whaleships. Zoologica 19(1):3-50.

VanStone, J.W. 1958. Commercial whaling in the Arctic Ocean. Pac. Northwest Quart. 49(1):1-10.

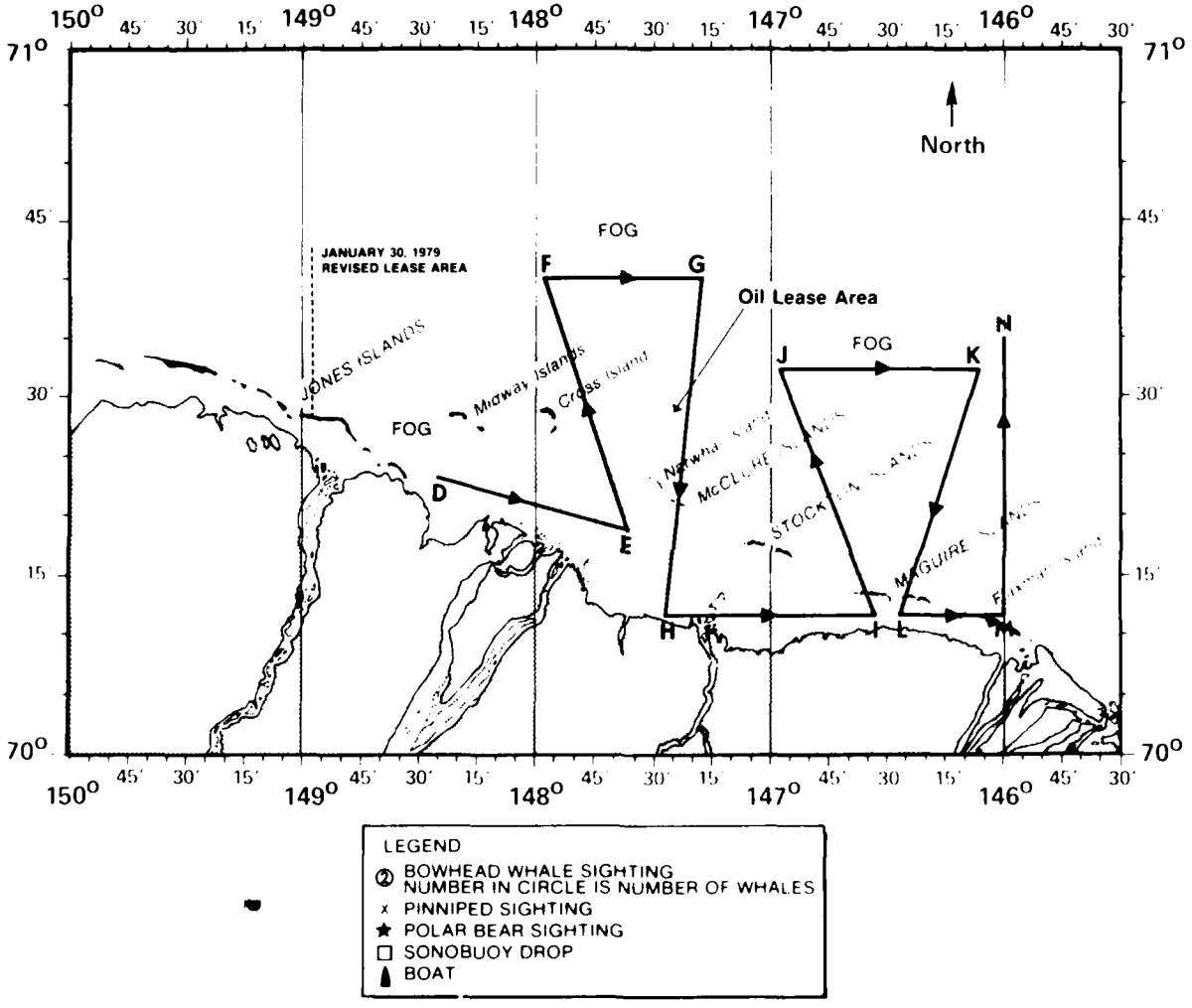
VanStone, J.W. 1962. Point Hope, an Eskimo village in transition. Univ. Wash. Press, Seattle, 117 pp.

Vibe, C. 1950. The marine mammals and the marine fauna in the Thule District (Northwest Greenland), with observations on ice conditions in 1939-41. Medd. om Grønland 150, 15 pp.

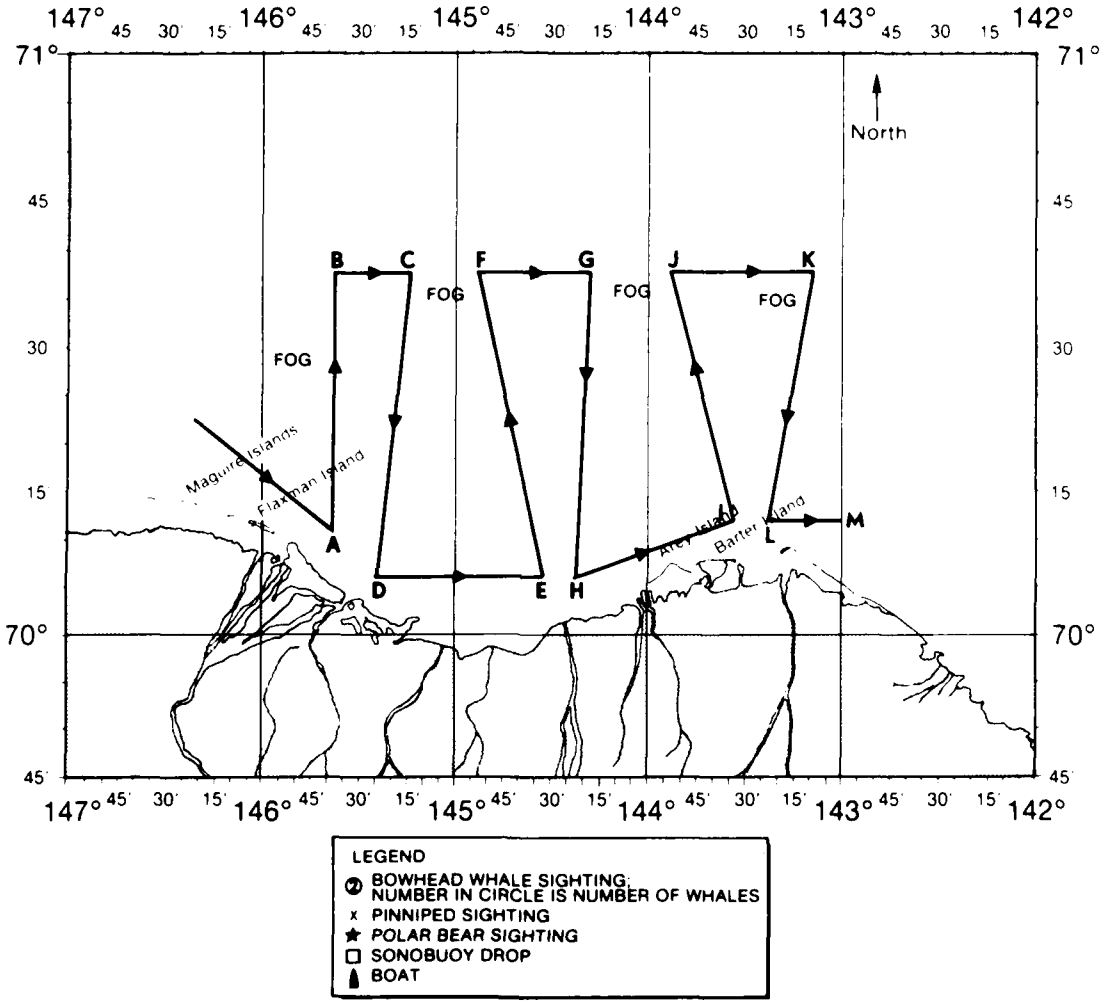
Zenkovich, B.A. 1952. Whales and whale hunting, Moscow, Pishchepromi dat.

## APPENDIX B

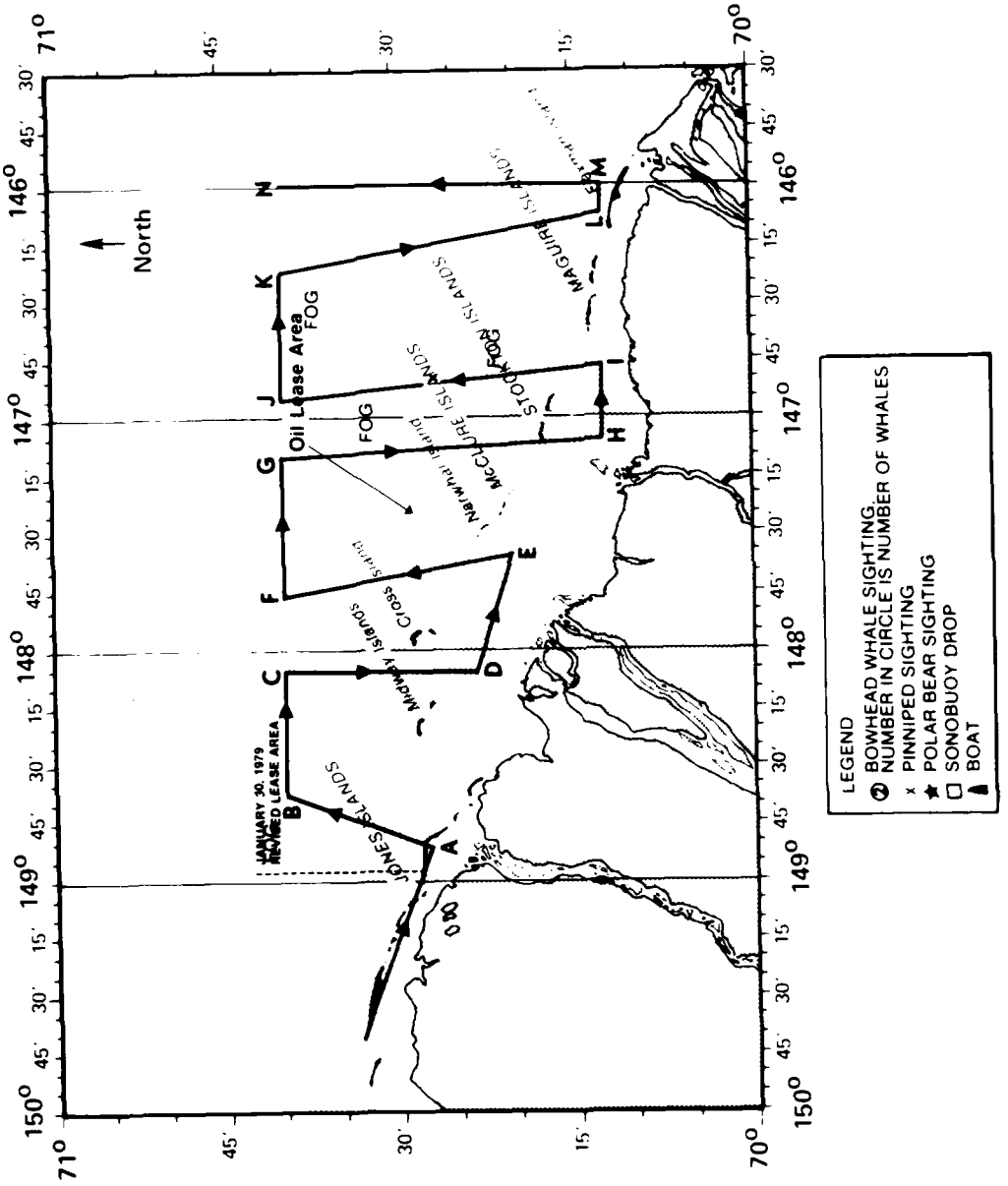
AERIAL SURVEY FLIGHTS #1 — 65 MADE DURING AUGUST, SEPTEMBER, AND OCTOBER 1979 OVER THE BEAUFORT SEA ON THE NORTH SLOPE OF ALASKA IN SEARCH OF BOWHEAD WHALES.



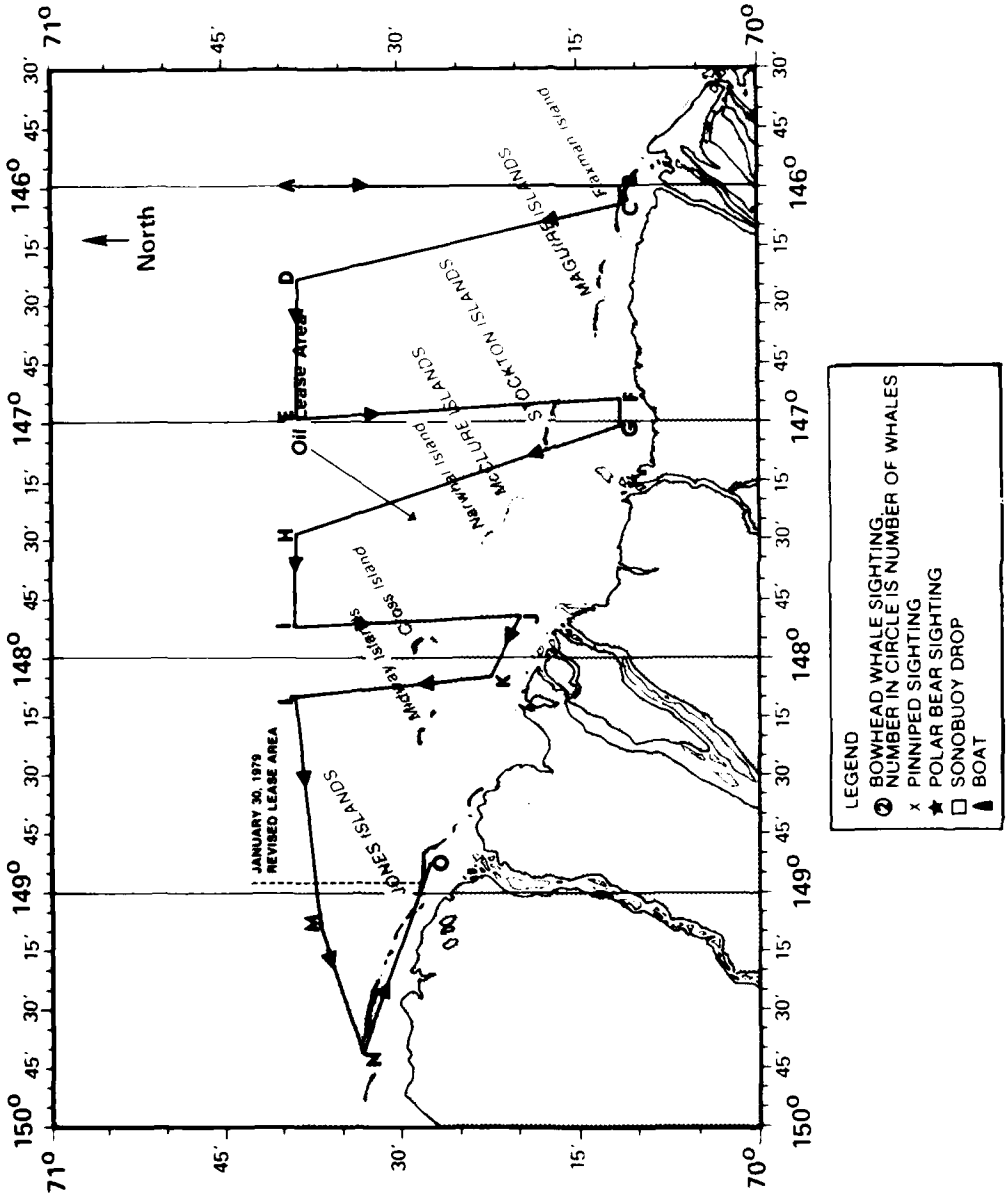

Flight 1, 2 August 1979, Block 41. No sightings were made. The transect was shortened by fog; otherwise the visibility was good. The water was open, with floating ice chunks present outside the barrier islands. Aircraft altitude was 1000 ft (305 m).



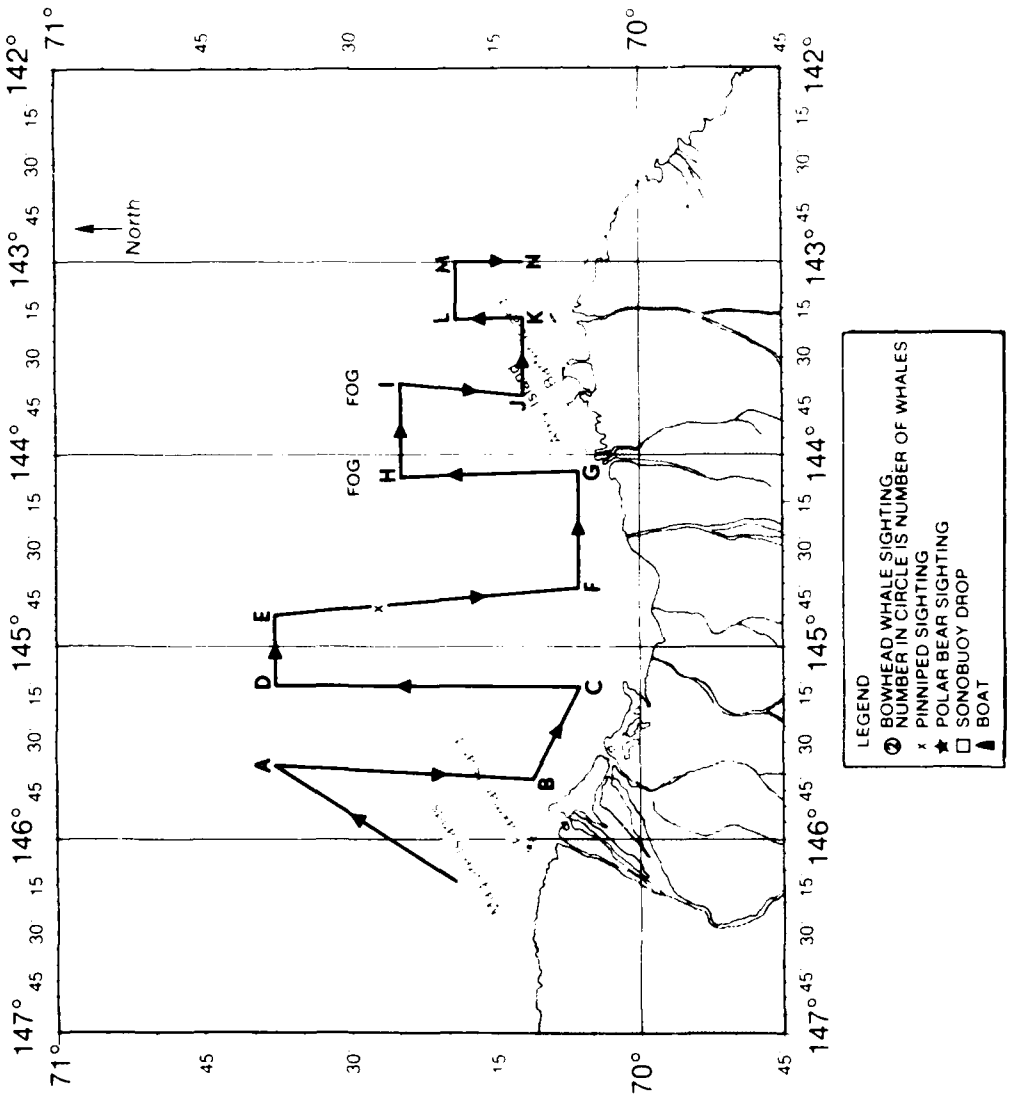

Flight 2, 5 August 1979, Block #3. No sightings were made. The northern survey edge was shrouded with fog. The transect was shortened on the east because of fog. Fog patches were present throughout the transect. Visibility ranged from very good to bad. Water conditions were open with densely packed floating ice chunks in the northern half of the survey, and thinly packed floating ice in the southern half. Aircraft altitude ranged from 70-1000 ft (21-305 m).



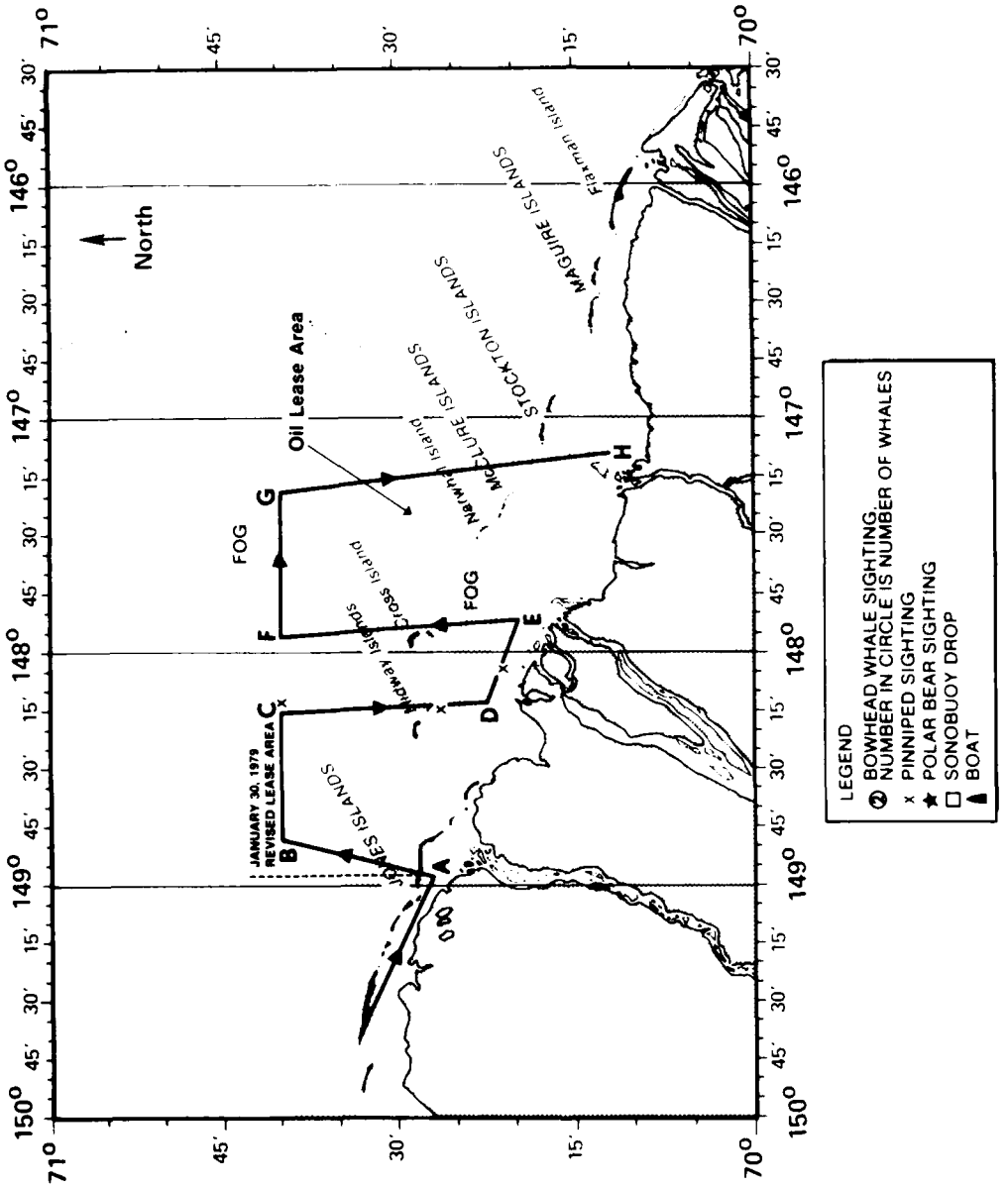

Flight 3, 8 August 1979, Block #1. One pinniped was sighted. A layer of thin fog with occasional dense patches was present throughout the area. Visibility ranged from very good to fair, and aircraft altitude was held at 800 ft (244 m). Open water extended beyond the barrier islands and floating ice chunks were noticeably smaller than before.



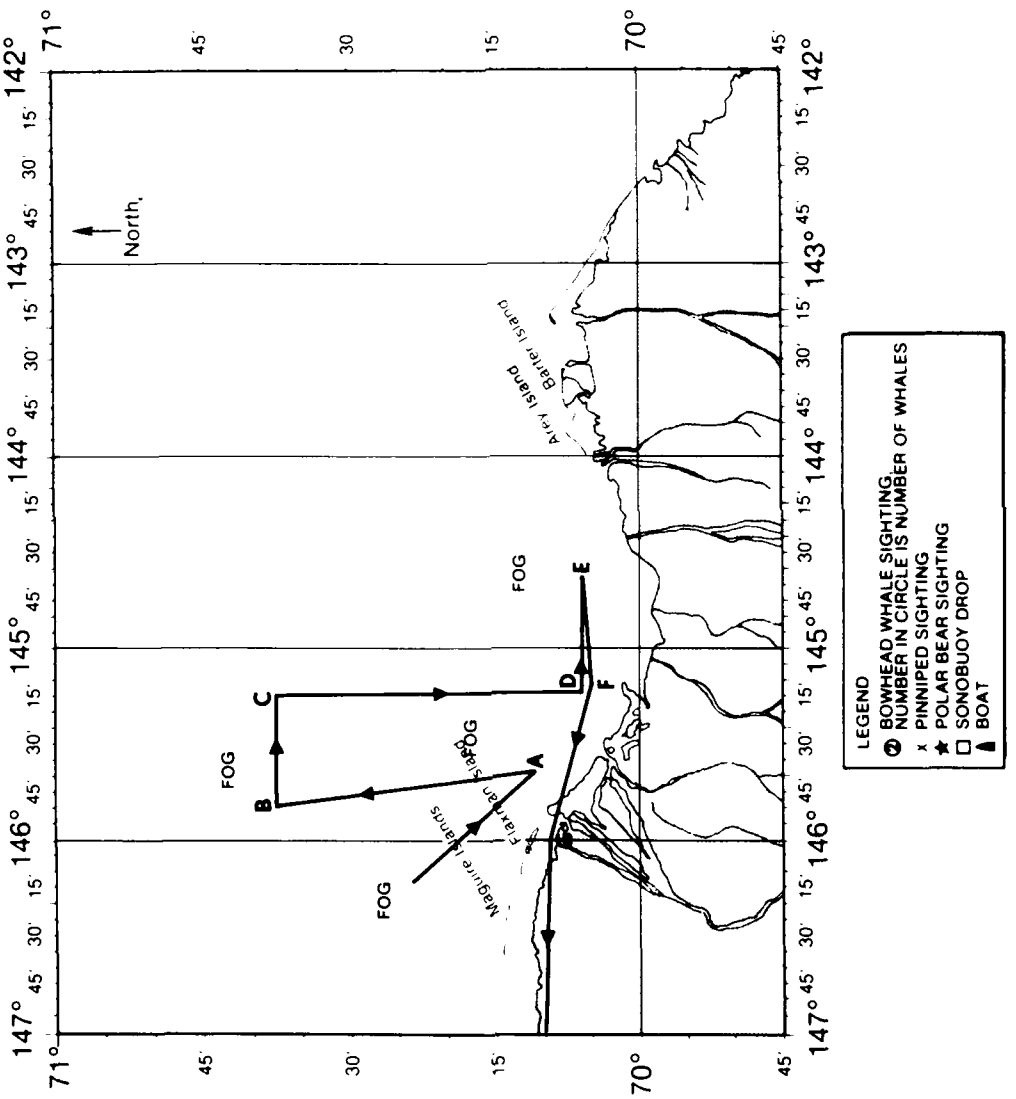

Flight 4, 15 August 1979, Block #1. No sightings were made. Visibility was good with scattered clouds and haze on the horizon. Open water again extended past the barrier islands before floating ice was present. Aircraft altitude was 1000 ft (305 m).



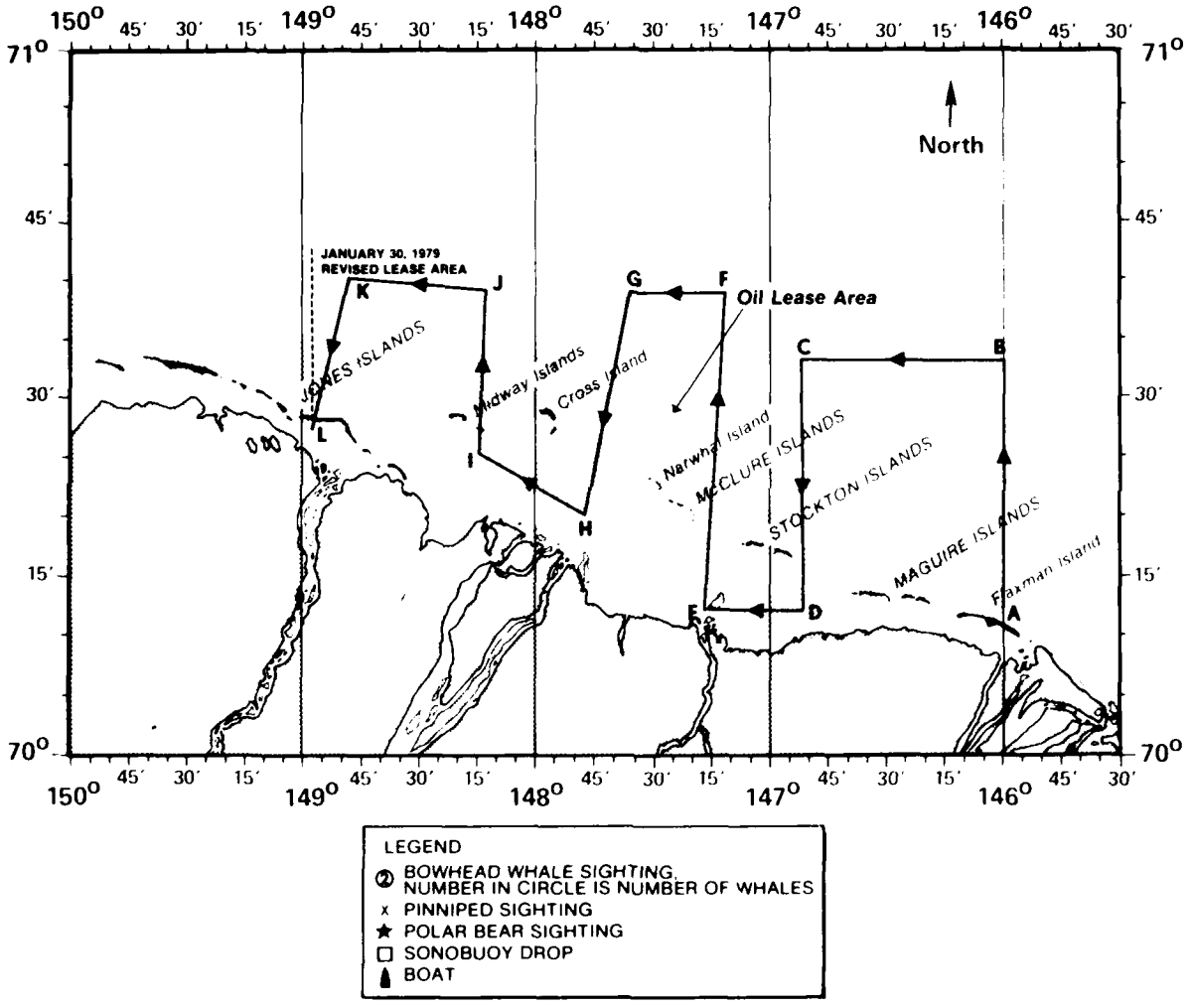

Flight 5, 16 August 1979, Block #3. One pinniped sighting, which consisted of two seals, was made. Weather conditions were mostly clear except for fog on the northeast side, which shortened the transect. The water was open, with some floating ice chunks outside the barrier islands. Aircraft altitude was 700 ft (213 m).



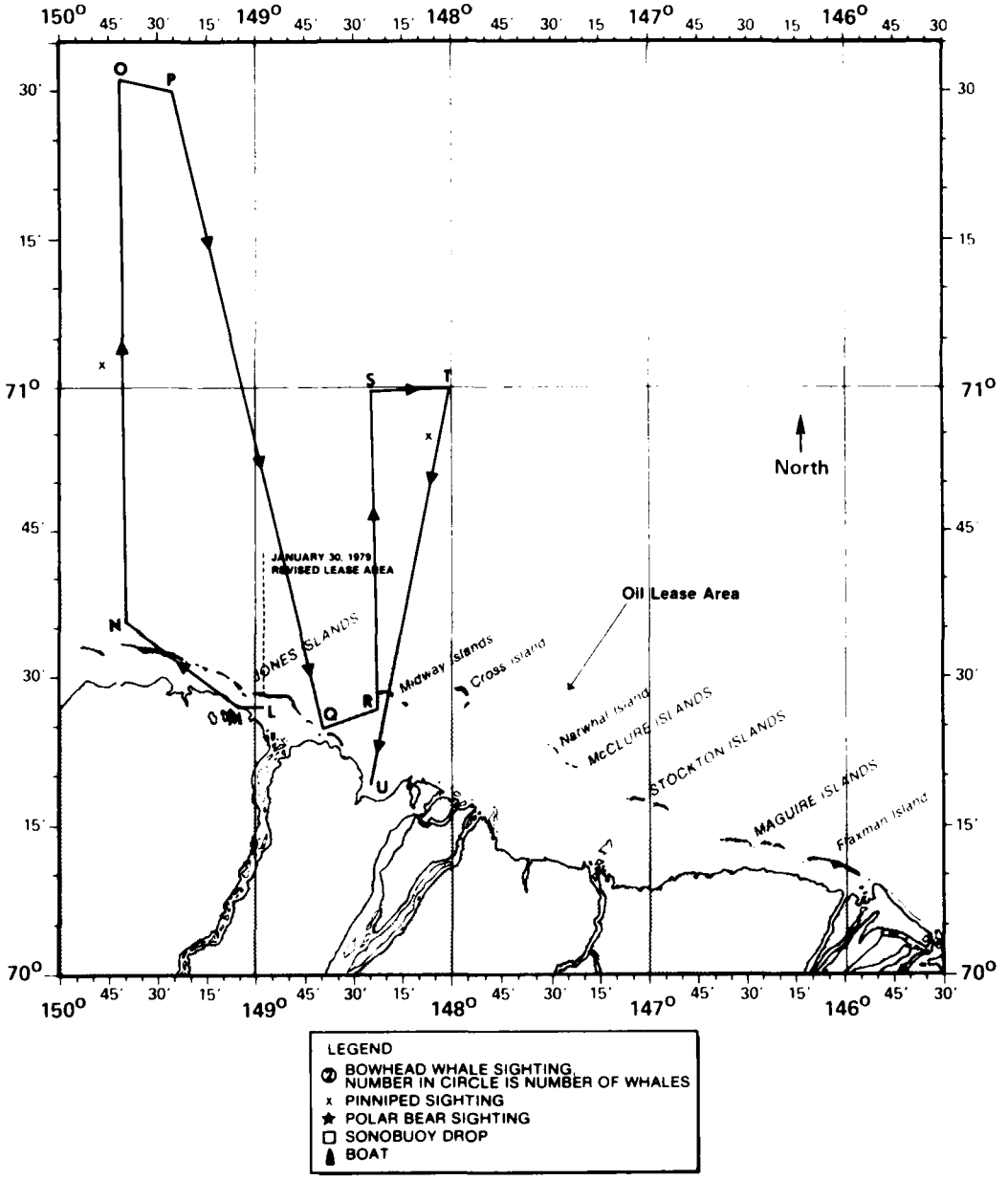

Flight 6, 18 August 1979, Block No. 1. Three pinniped sightings, totalling ten individuals, were made. Thick fog was present at the eastern edge, which shortened the transect. Visibility ranged from very good to very bad. The water was mostly open, with floating ice chunks up against the barrier islands. Aircraft altitude was 1000 ft (305 m).




Flight 7, 19 August 1979, Block #3. No sightings were made and the transect was severely hindered by fog. Visibility ranged from very good to very bad. The water was mostly open. Aircraft altitude was 1000 ft (305 m).




Flight 8-A, 20 August 1979, Block #1. No sightings were made. The sky was overcast and visibility ranged from very good to fair because of occasional fog patches. Water conditions were open, with floating ice chunks up against the barrier islands. Aircraft altitude was 1000 ft (305 m).

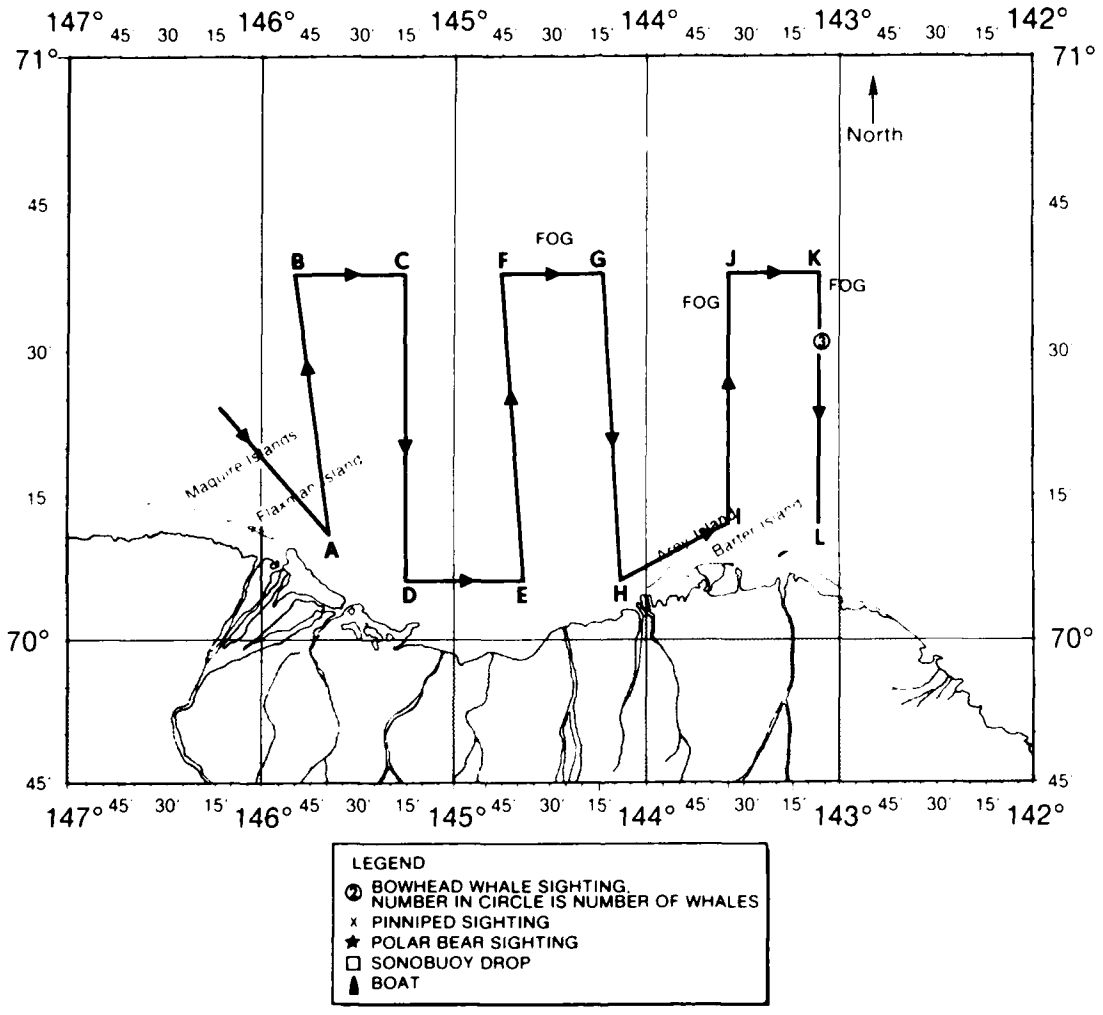



Flight 8-B, 20 August 1979, Blocks #1 and 2. Two pinnipeds were sighted. This flight is a north extension of flight 8-A. The transect was limited by fog on the north and east edges. Floating ice chunks were present and aircraft altitude was 1000 ft (305 m).

Table B1. Bowhead whale sightings for flight 9, 20 August 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 3; 1 was unidentified | 70°31'54" | 143°06'30" | -- | 50 | -- | O | | Dove |

*O – original sighting.



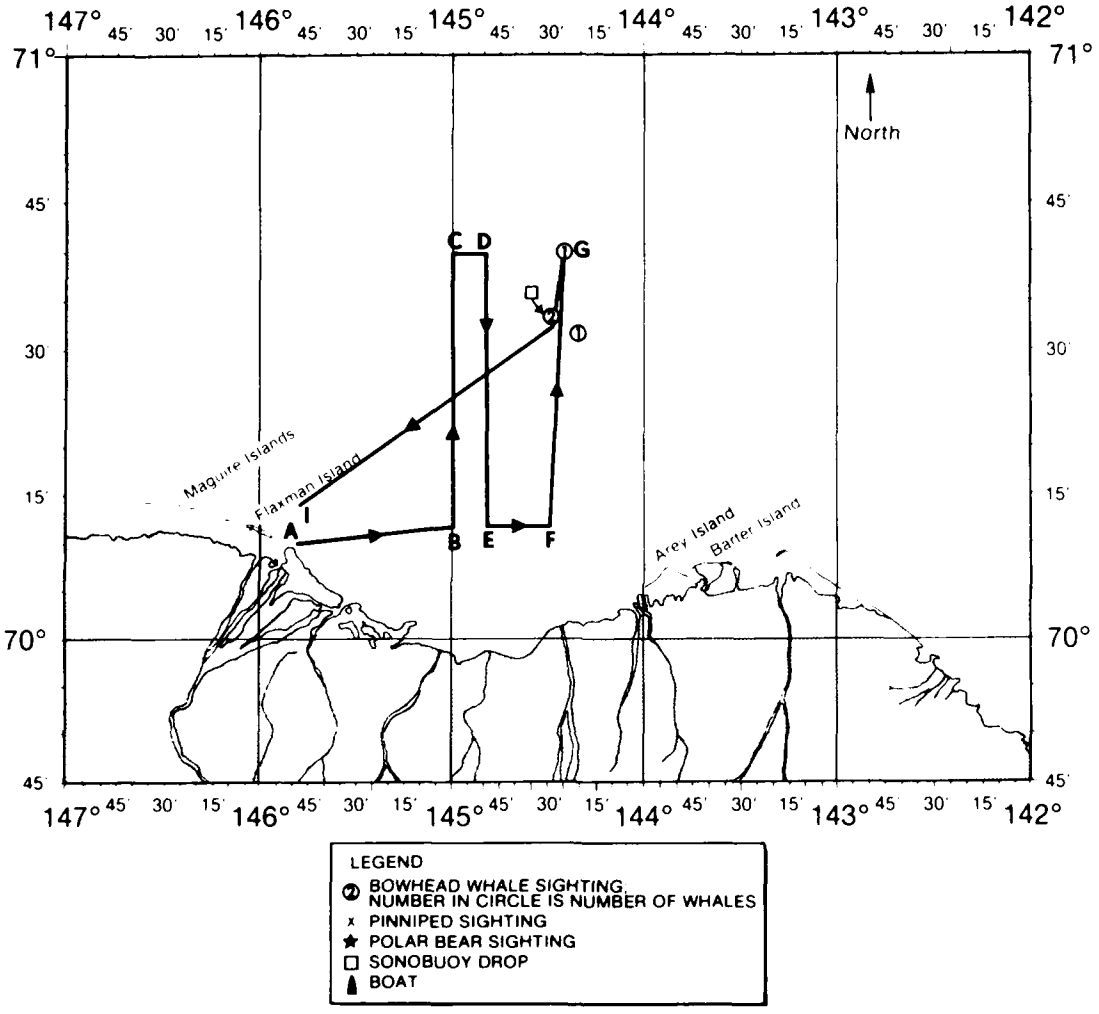

Flight 9, 20 August 1979, Block #3. Two bowheads and one large, unidentified whale were sighted; all whales were at the same location (table B1). Thin fog was present at the northeast corner; visibility ranged from good to poor. The water was almost entirely open, with some floating ice present at the northwest edge and just north of Barter Island. Aircraft altitude was 1000 ft (305 m).

Table B2. Bowhead whale sightings for flight 10, 21 August 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

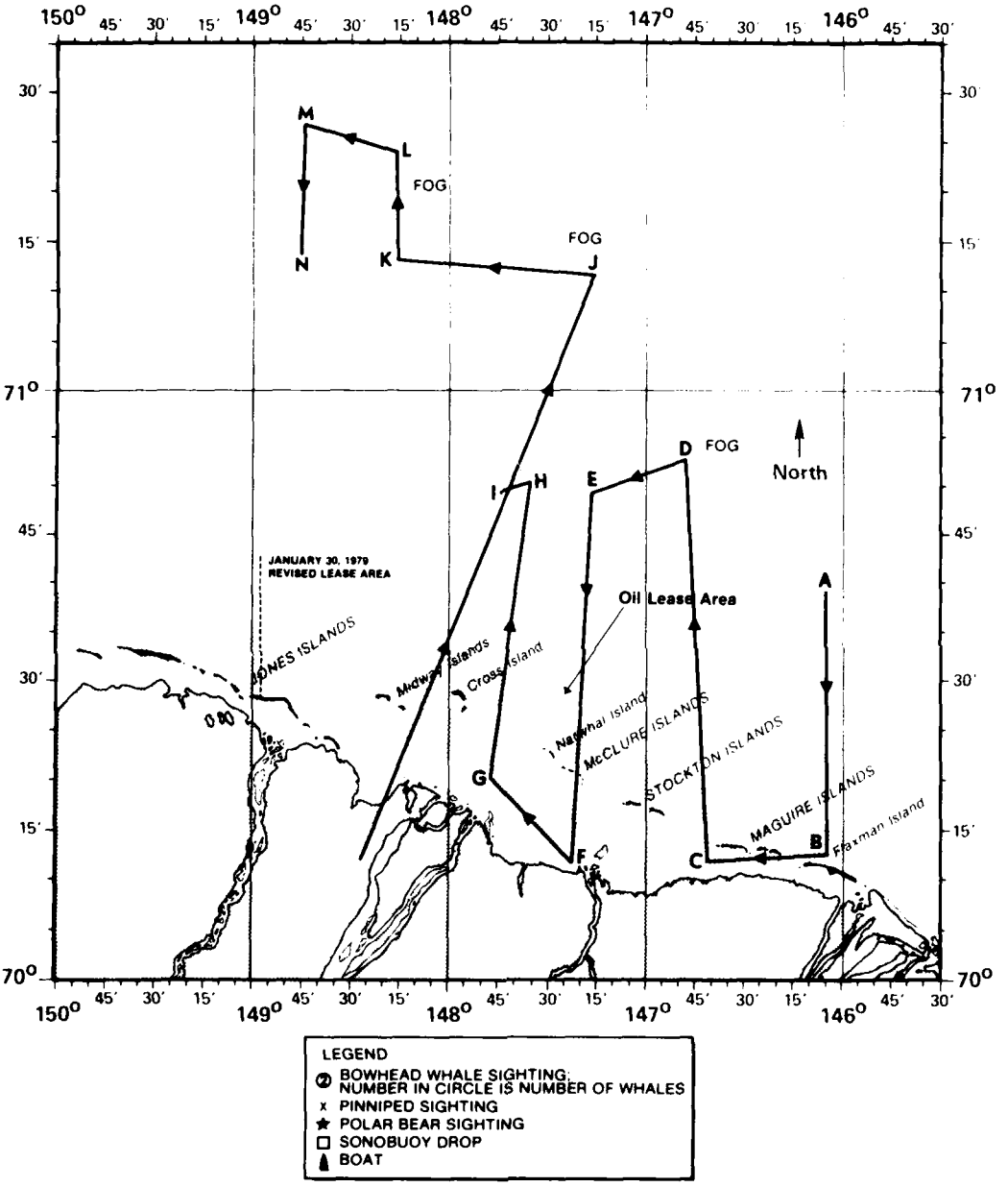
| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°31'36" | 144°22'00" | – | – | 248 | O | | Dove |
| 2 | 70°33'24" | 144°29'36" | – | – | – | O | | Blew and dove |
| 1 | 70°40'36" | 144°25'36" | – | – | – | R | | Dove |

*O – original sighting.

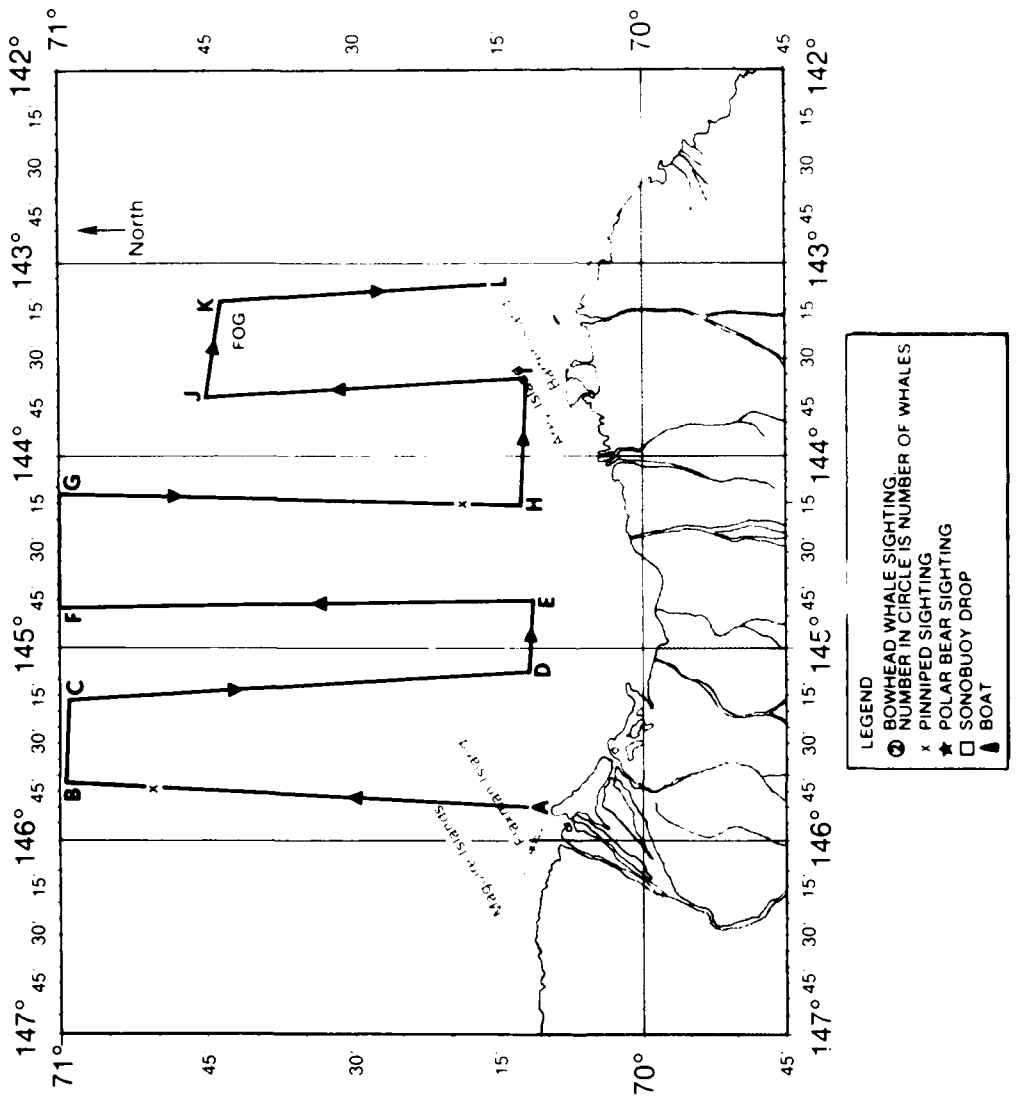
R – possible resighting.



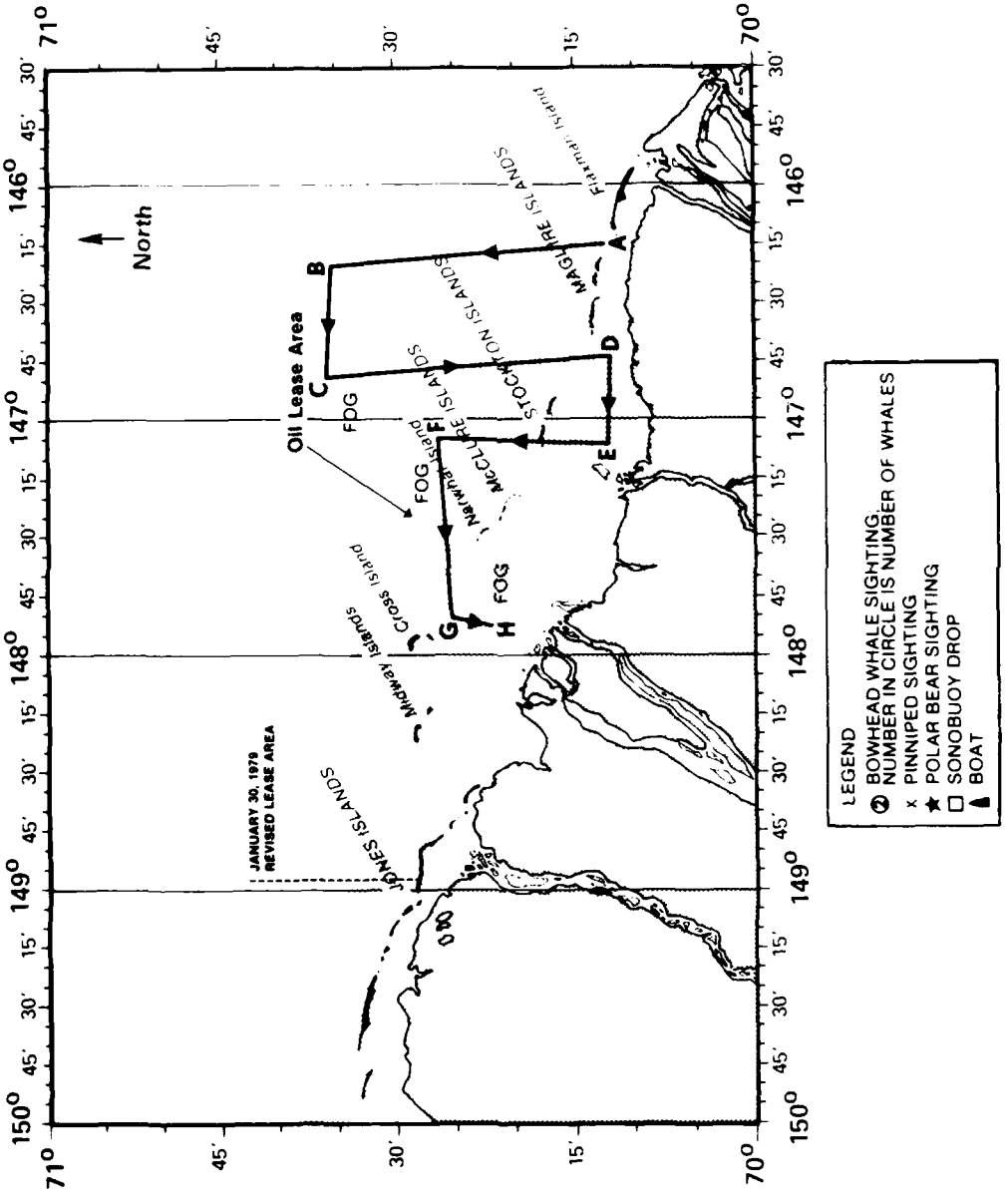

Flight 10, 21 August 1979, Block #3. Three bowhead whale sightings were made, for a total of four whales (table B2). One sonobuoy was dropped; its position is approximate. The day was clear with excellent visibility. The water was very open, with floating ice chunks present only to the west. Aircraft altitude was 1000 ft (305 m).



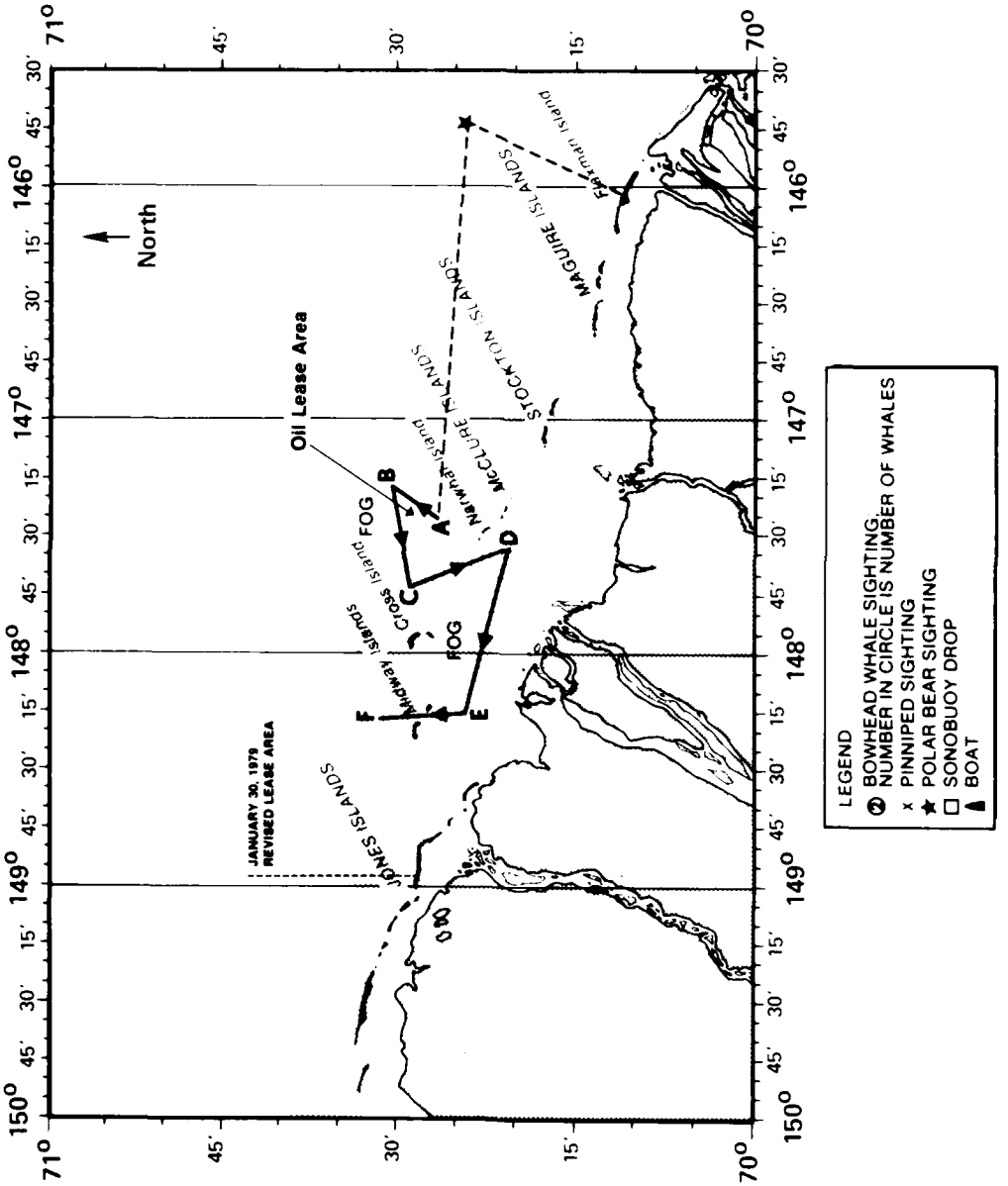

Flight 11, 25 August 1979, Blocks #1 and 2. No sightings were made. Thick to thin fog throughout the survey caused considerable modification of the transect. The water was mainly open, with floating ice present beyond the barrier islands. Aircraft altitude ranged from 200-1500 ft (61-457 m).



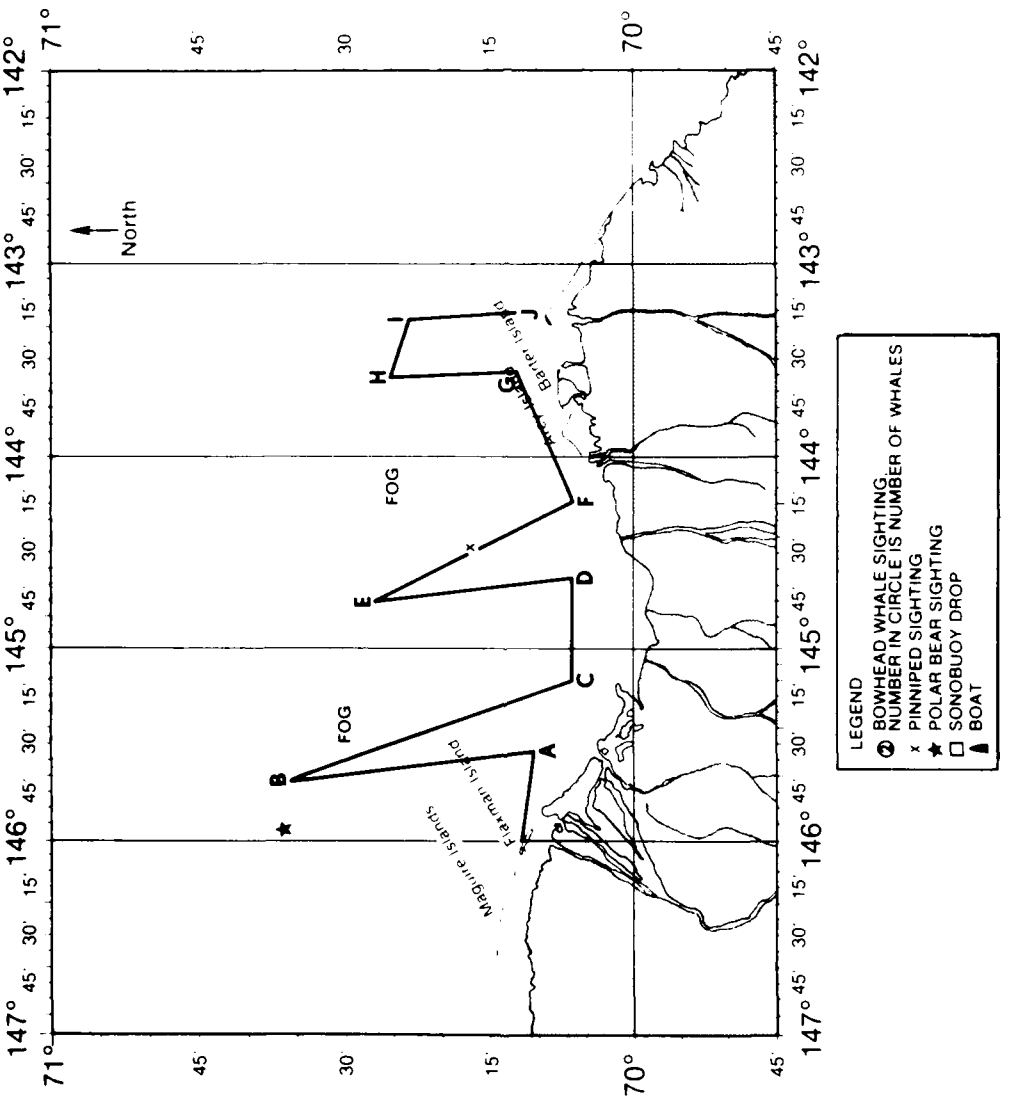

Flight 12, 25 August 1979, Block #3. Two pinniped sightings were made. Heavy fog present at eastern edge shortened the transect. Visibility ranged from good to bad. The water was mostly open, with floating ice chunks. Aircraft altitude ranged from 500-1000 ft (152-305 m).



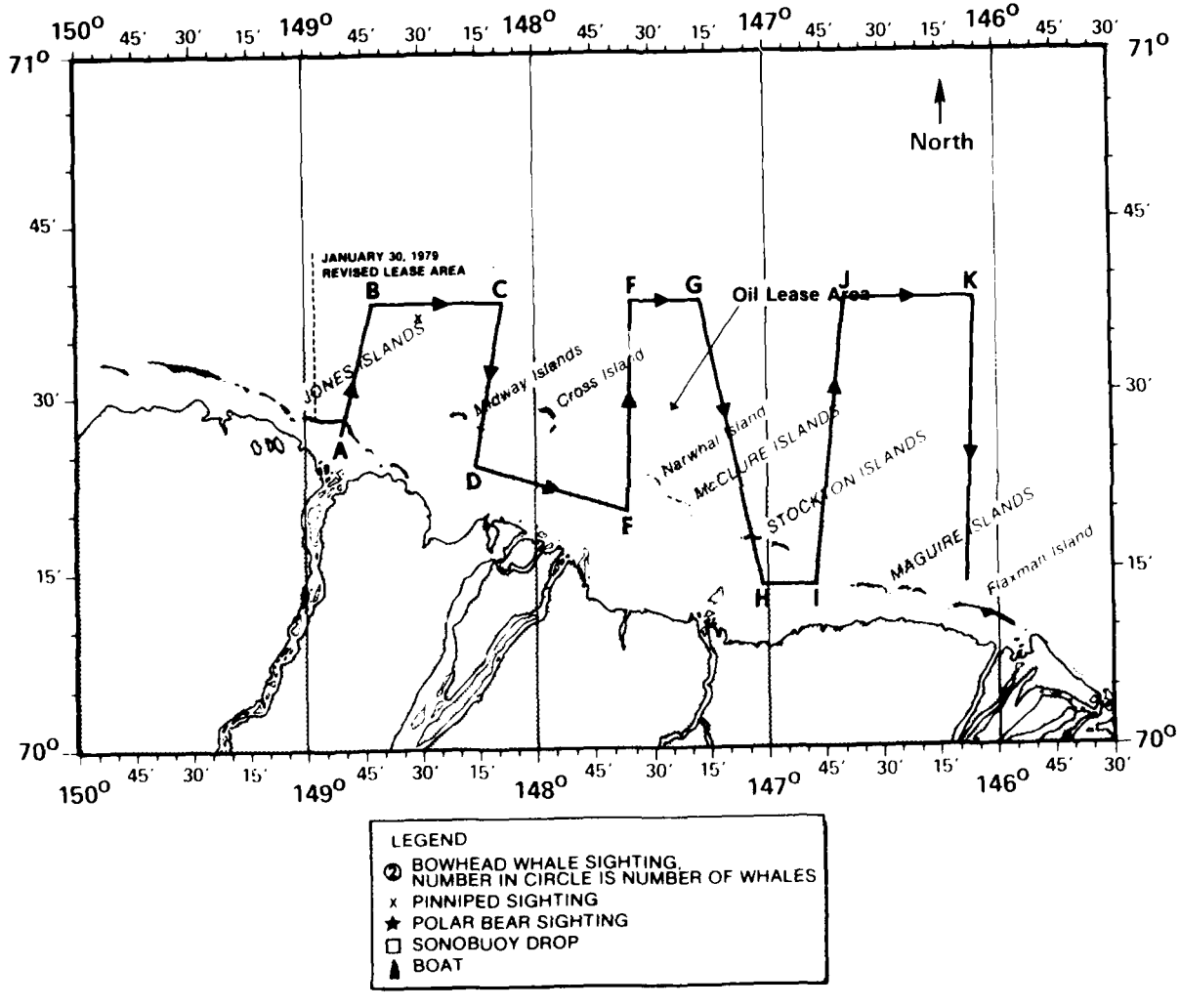

Flight 13, 28 August 1979, Block #1. No sightings were made, and heavy fog resulted in a partial transect. The water was mostly open, with scattered floating ice chunks. Aircraft altitude ranged from 150-1000 ft (46-305 m).



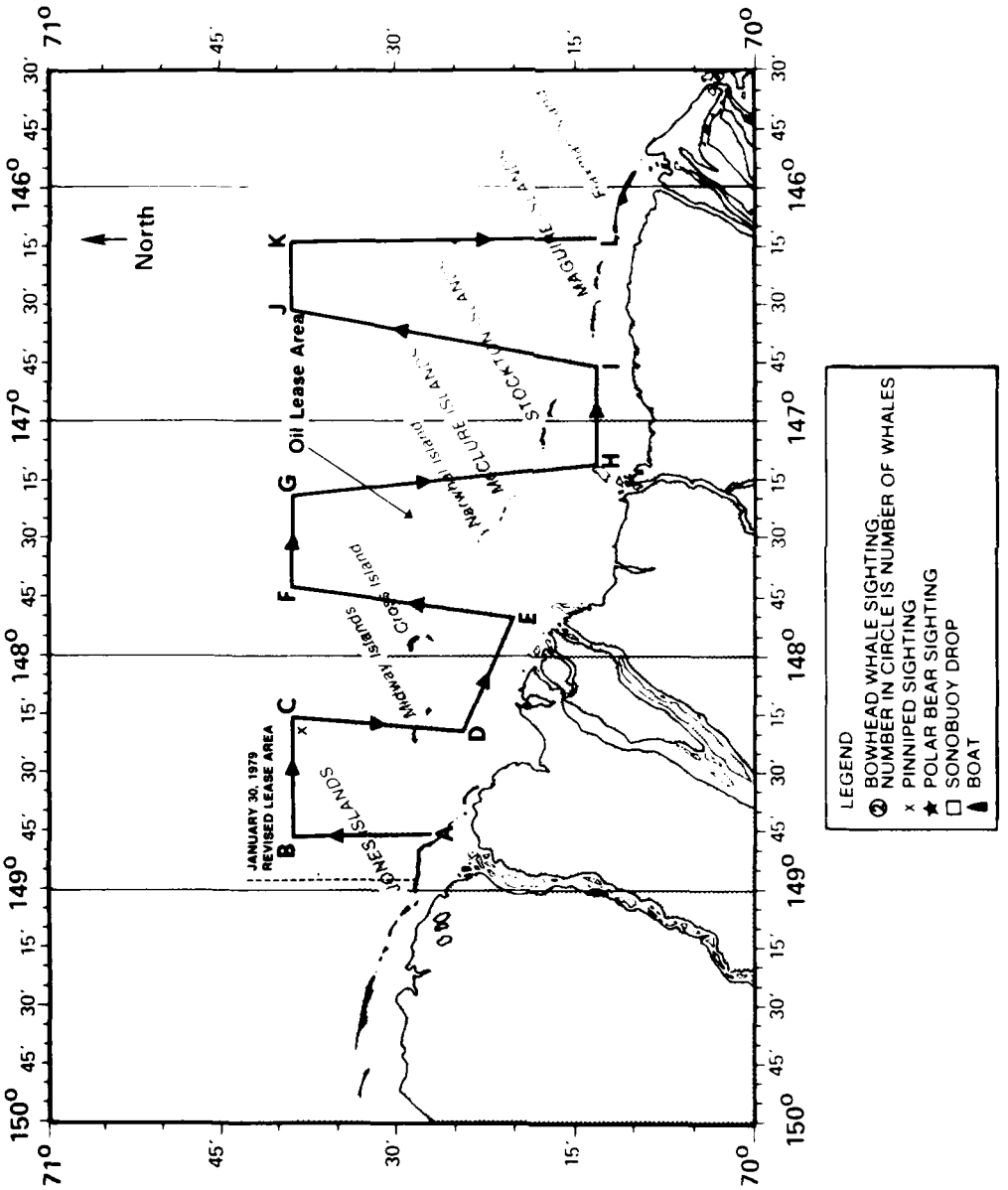

Flight 14, 30 August 1979, Block #1. Two polar bear sightings, for a total of five individuals (one adult with a yearling and one adult with two cubs), were made. Transect was shortened and terminated because of fog. Dashed line shows transect through fog to a clear area, which then fogged in. Ice chunks were present only beyond barrier islands. Aircraft altitude ranged from 200-1000 ft (61-305 m).



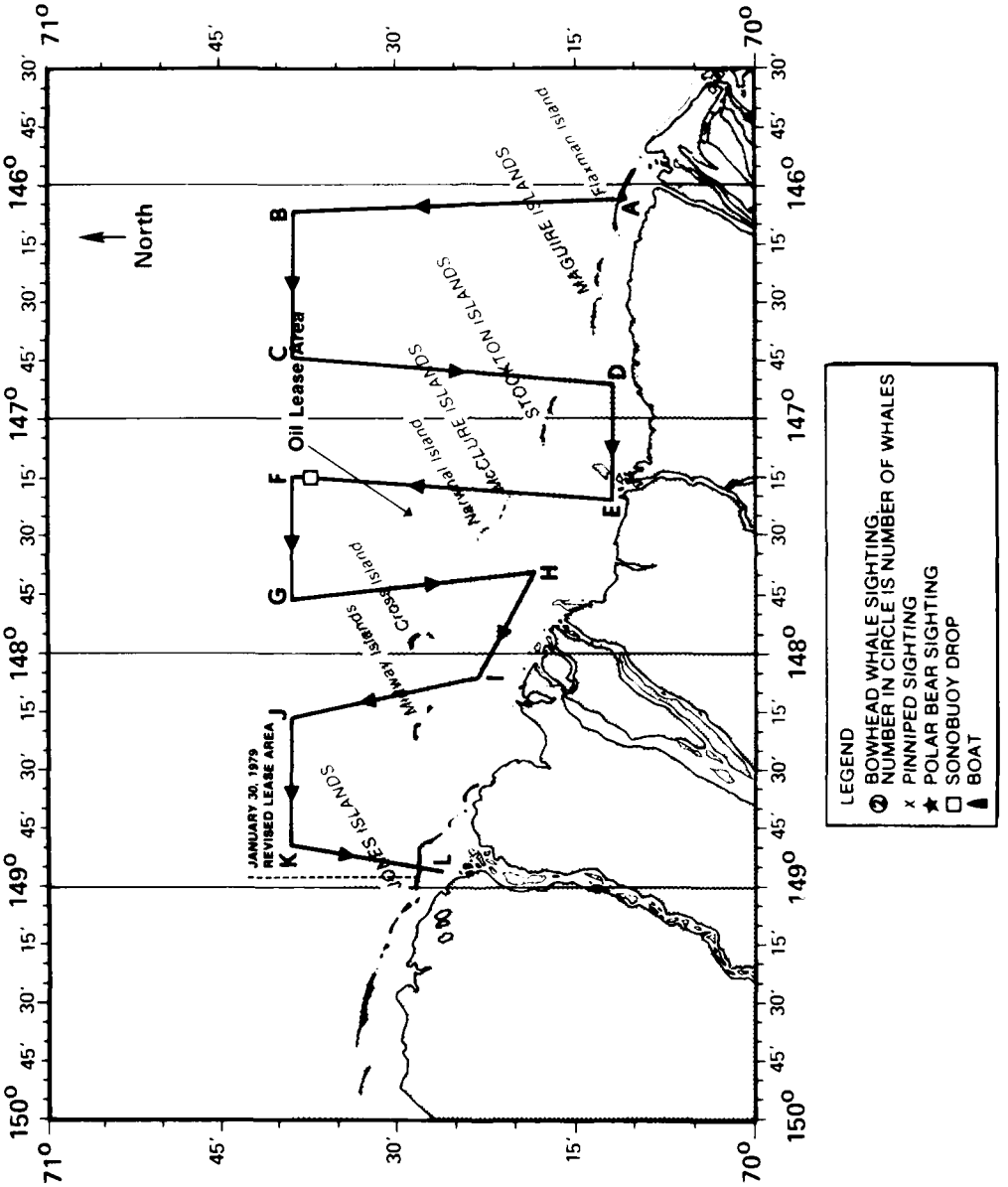

Flight 15, 30 August 1979, Block #3. One pinniped was seen. One polar bear sighting (adult with two cubs feeding) was made. Ice chunks were present in water. Visibility was good, with a fog bank to the north. Aircraft altitude was 1000 ft (305 m).



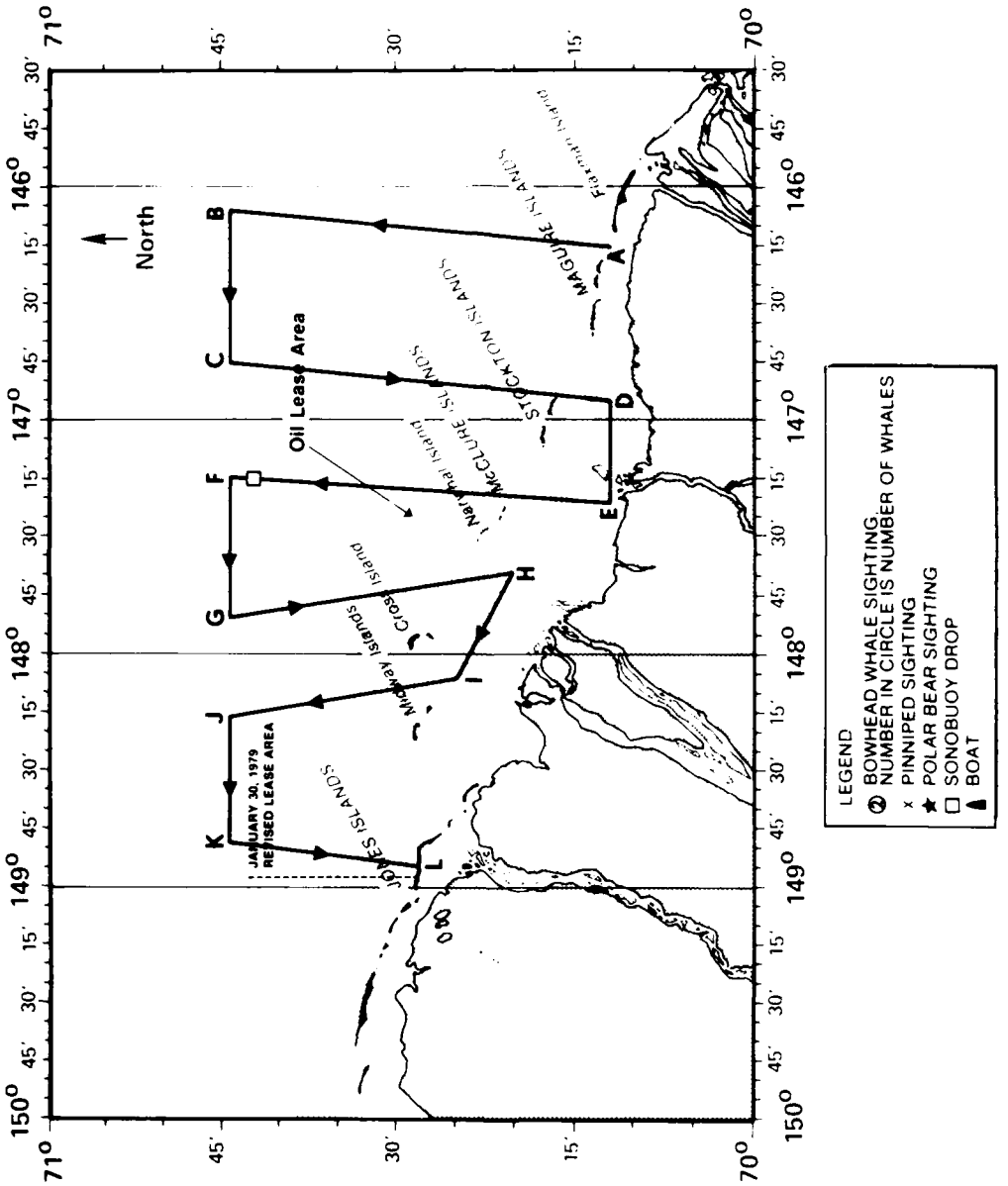

Flight 16, 31 August 1979, Block #1. One pinniped sighting was made. Visibility was good under overcast skies. The water was calm and open, with strip ice along the northern edge of the barrier islands. Altitude ranged from 200-500 ft (61-152 m).



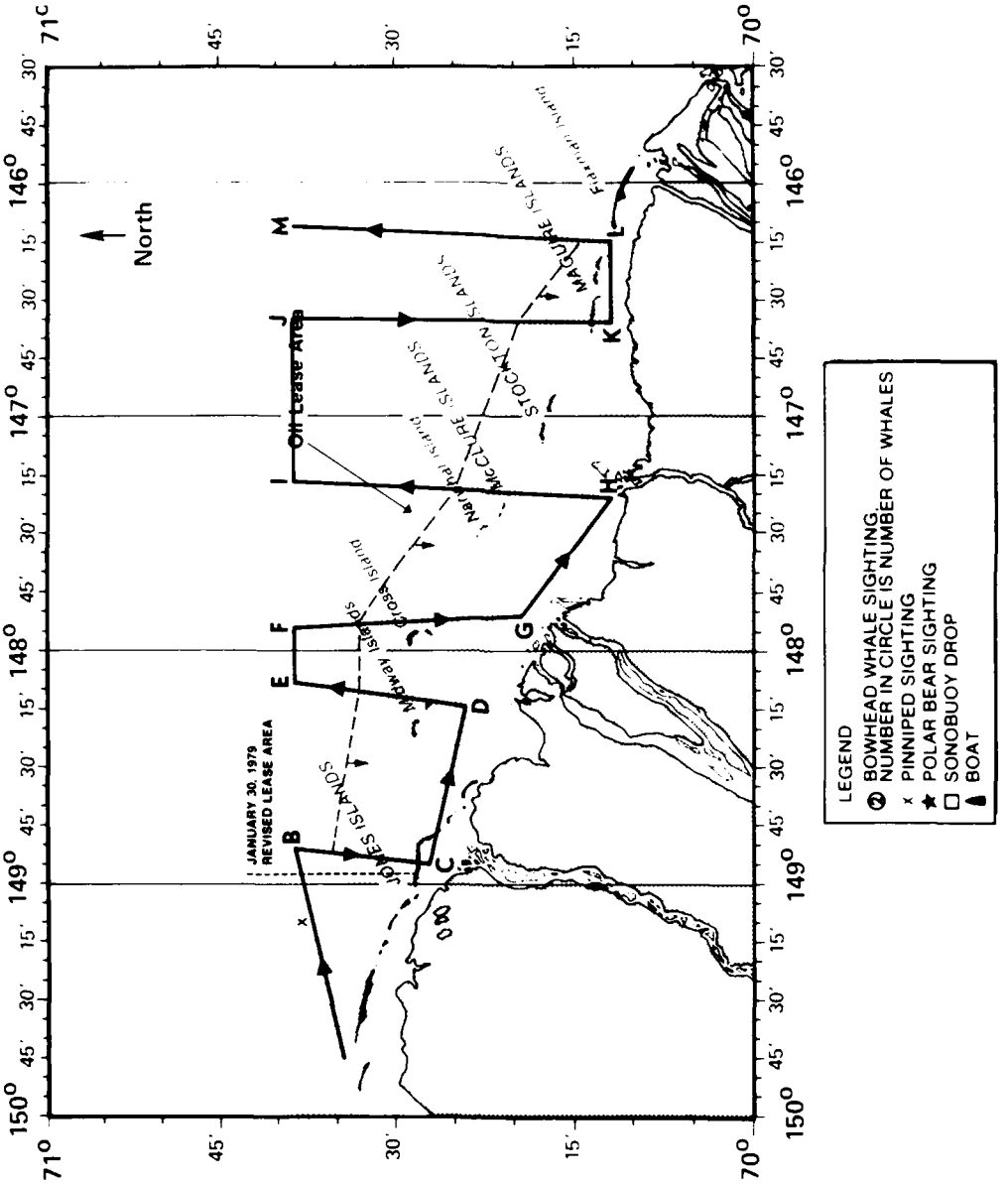

Flight 17, 31 August 1979, Block #1. One pinniped sighting of four walrus was made. Visibility was good under overcast skies, with a few fog patches present. Water was mostly open, with strip ice along the northern side of the barrier islands. Aircraft altitude ranged from 150-400 ft (46-122 m).




Flight 18, 7 September 1979, Block #1. No sightings were made. One sonobuoy was dropped. Visibility was unlimited, and water was open, with strip ice along the northern edge of the barrier islands. Aircraft altitude was 1000 ft (305 m).




Flight 19, 7 September 1979, Block #1. No sightings were made. One sonobuoy was dropped. Visibility was excellent, with calm, clear weather. Strip ice was present only along the northern side of the barrier islands. Aircraft altitude ranged from 700-1000 ft (213-305 m).

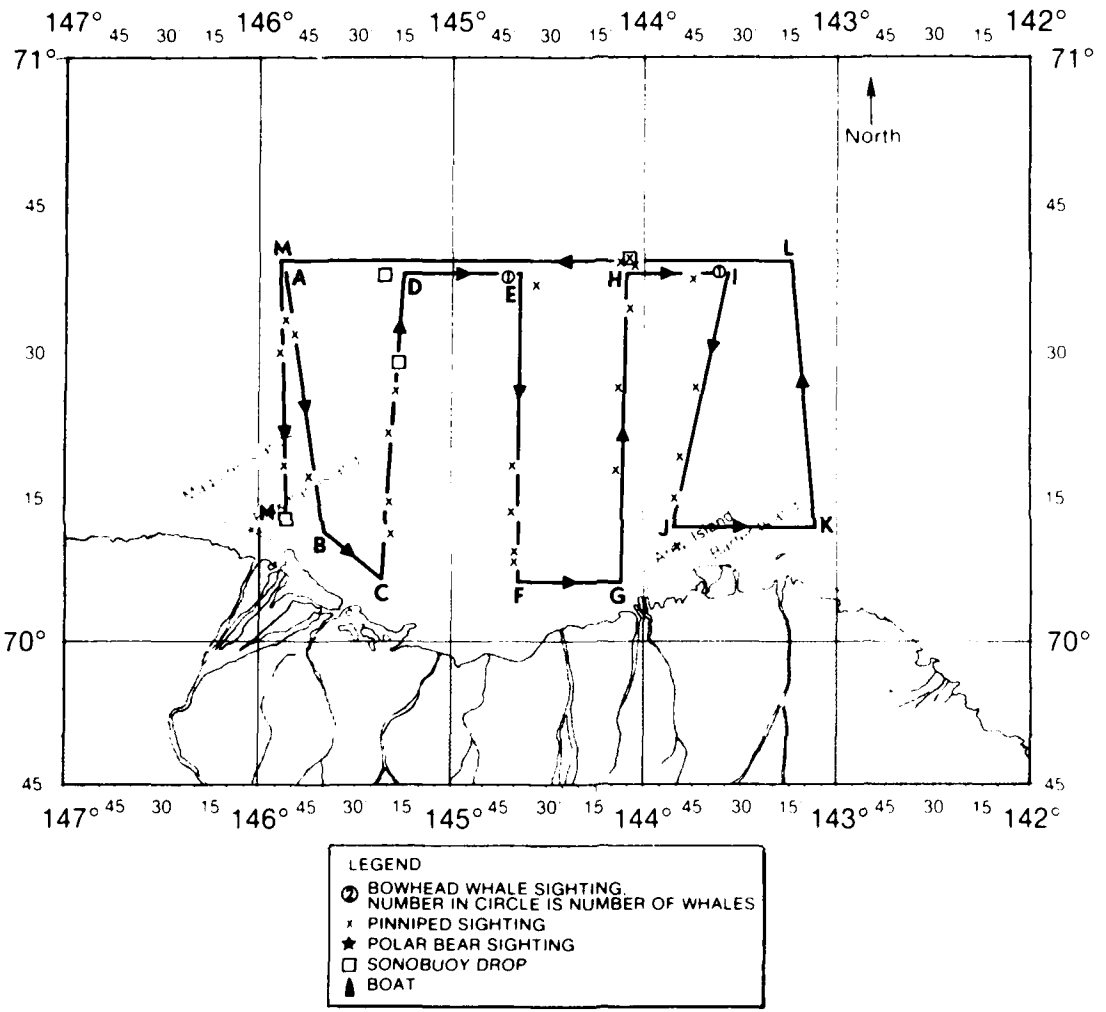



Flight 20, 7 September 1979, Block #1. One pinniped sighting of two walrus was made. The dotted line indicates the general northern limit of strip ice, usually lying next to the offshore edge of the barrier islands. Visibility was excellent with clear weather. Aircraft altitude was 1000 ft (305 m).

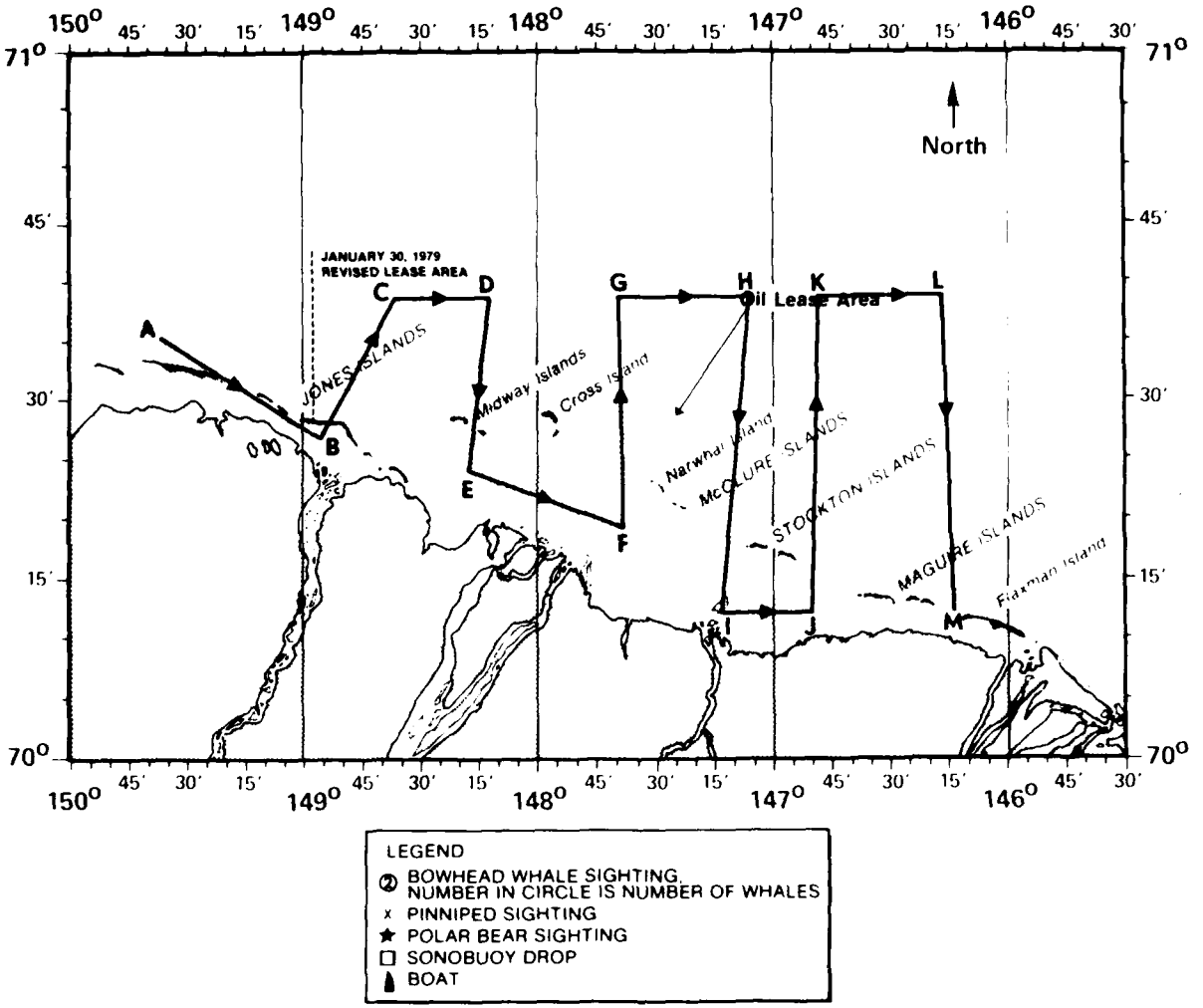
Table B3. Bowhead whale sightings for flight 21, 7 September 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°37'2" | 144°42'48" | 1000/305 | 17 | 270 | O | | Remained on surface |
| 1 | 70°38'30" | 143°38'2" | 1000/305 | 40 | 270 | O | | Dove immediately |

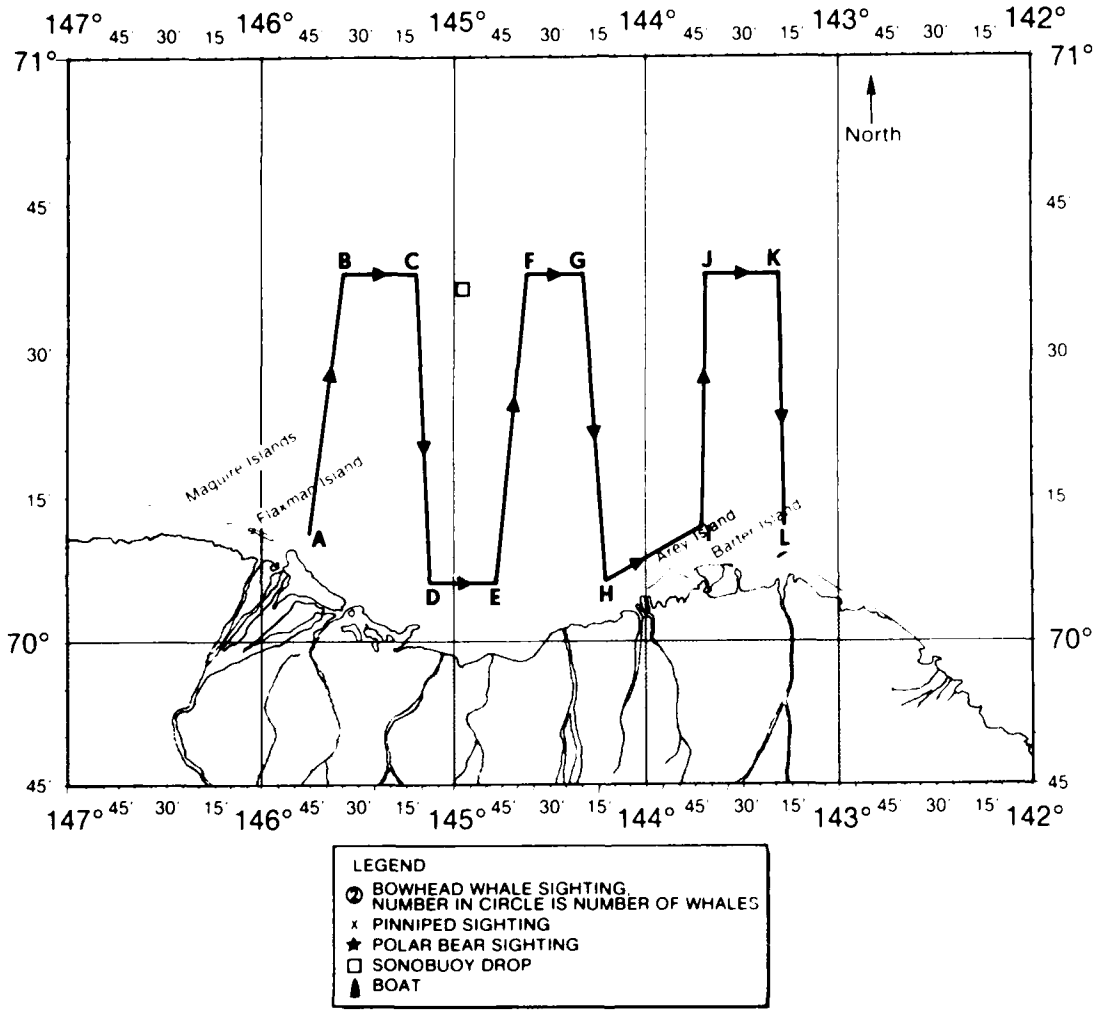
*O - original sighting.



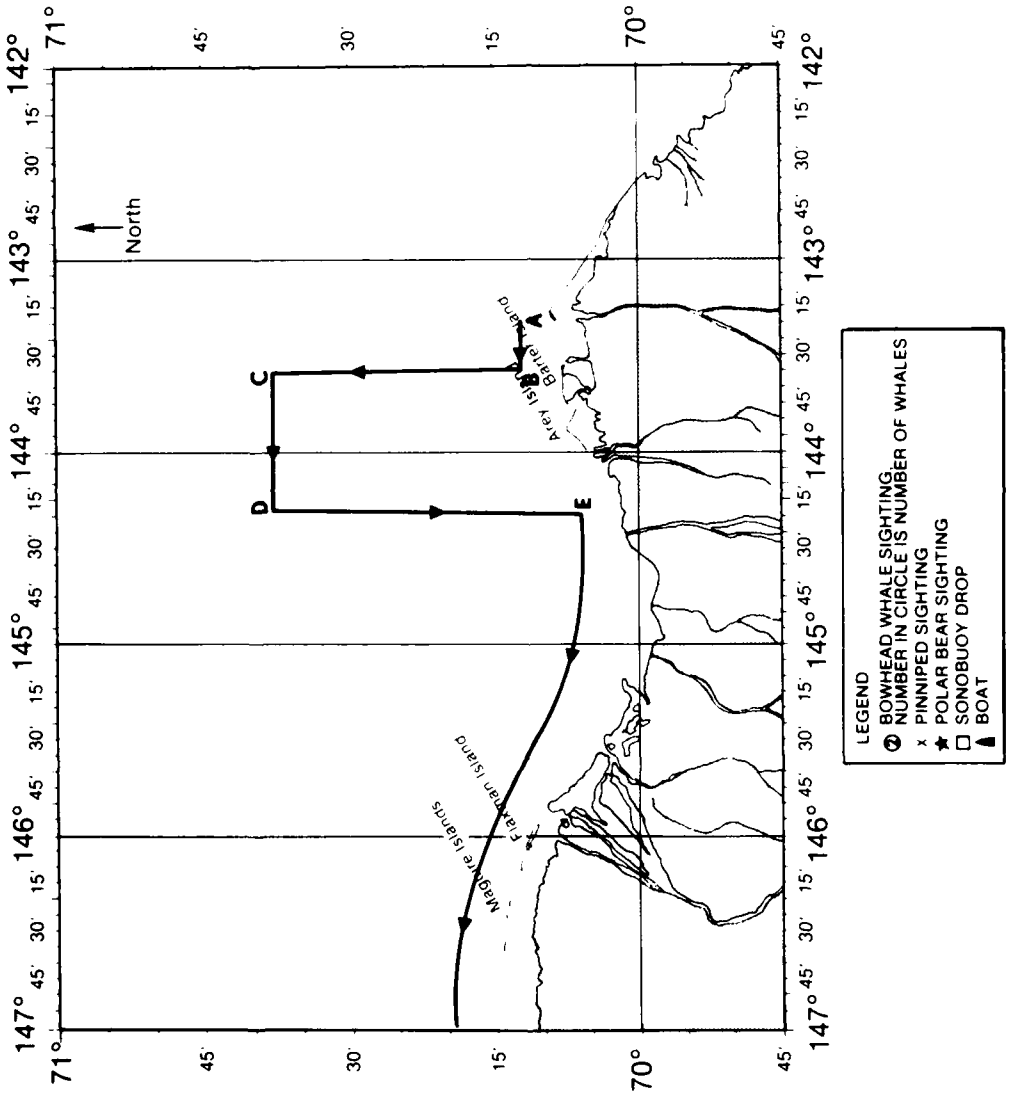

Flight 21, 7 September 1979, Block #3. Two bowhead whale sightings were made for a total of two individuals (table B3). Twenty-seven pinniped sightings were made for a total of 62 individuals. Four sonobuoys were dropped. Visibility was excellent, with clear skies, and the water was mostly open. Aircraft altitude ranged from 1000-1900 ft (305-597 m).



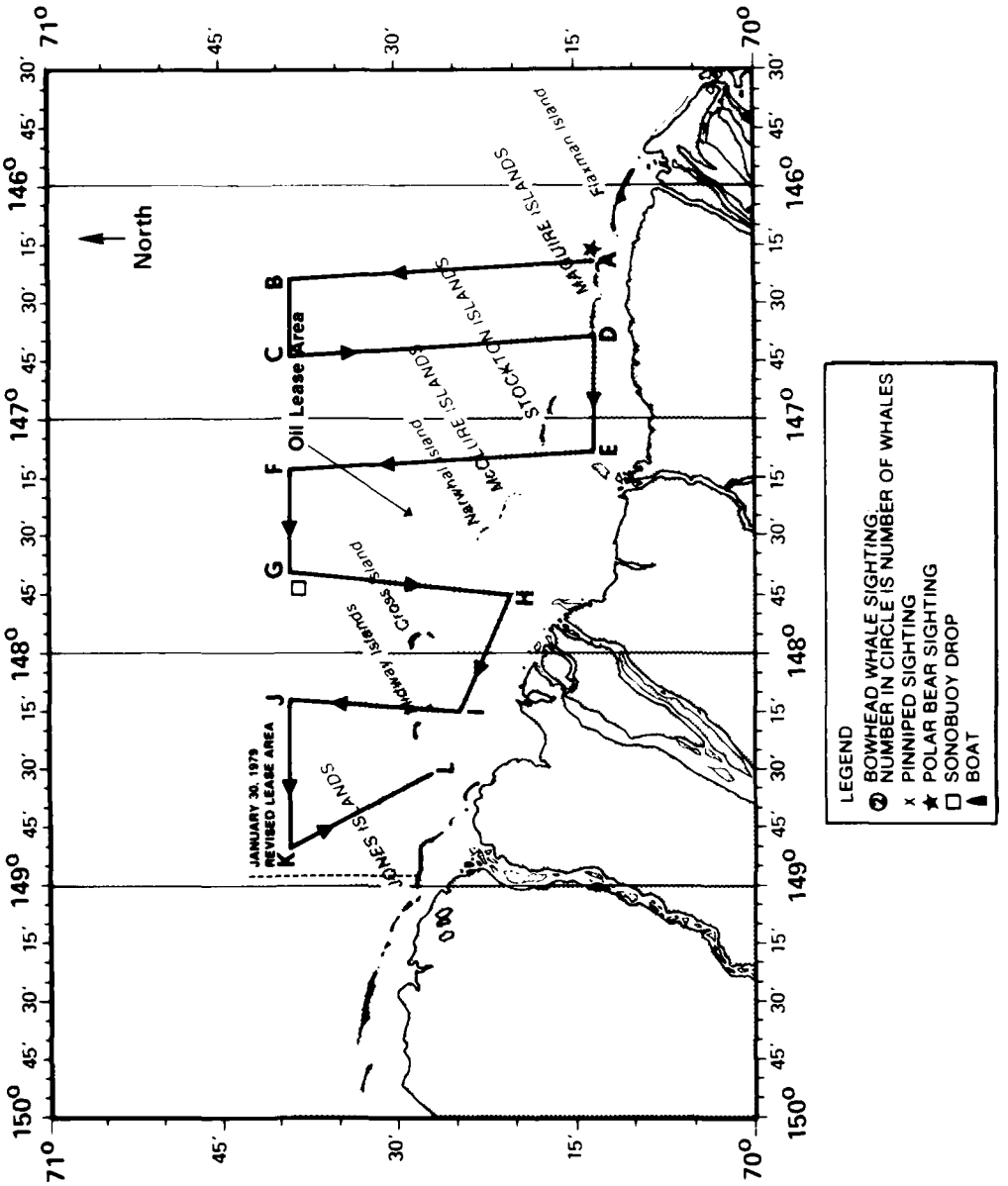

Flight 22, 12 September 1979, Block #1. No sightings were made. Visibility was good under overcast skies with moderate winds. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 200-1100 ft (61-335 m).



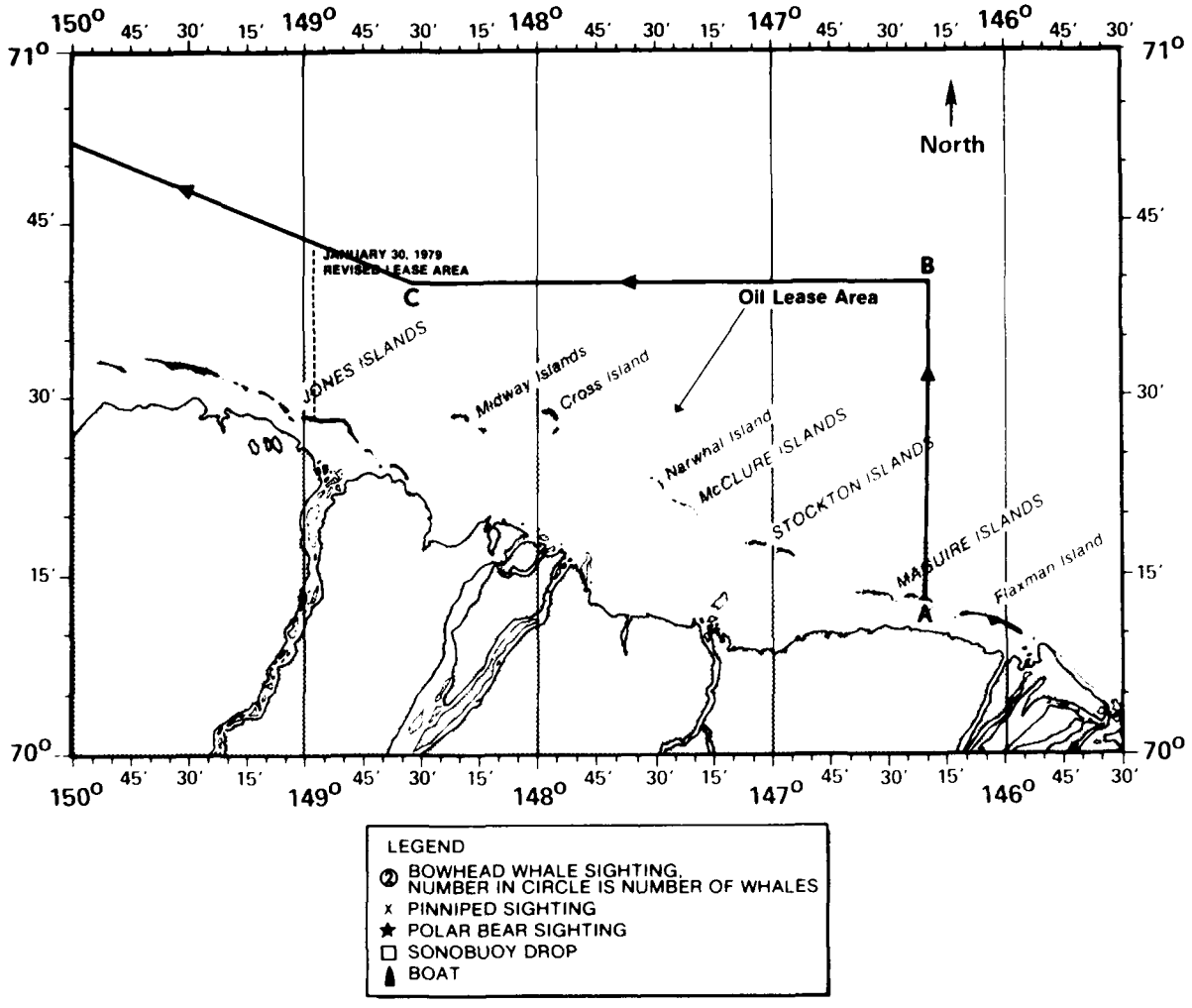

Flight 23, 12 September 1979, Block #3. No sightings were made; one sonobuoy was dropped. Visibility was good, with cloudy skies and some wind. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 900-1300 ft (274-396 m).




Flight 24, 12 September 1979, Block #3. No sightings were made. This flight is the return portion of flight 23. Visibility was good, with a moderate wind. The flight was terminated because of imminent fuel shortage. Aircraft altitude ranged from 900-1300 ft (274-396 m).




Flight 25, 13 September 1979, Block #1. One polar bear sighting of four individuals was made. One sonobuoy was dropped. Visibility was good, with moderate winds. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 400-1100 ft (122-335 m).




Flight 26, 13 September 1979. No sightings were made. This flight is a typical line transect from Deadhorse to Barrow and is only shown as an example. Visibility was good, with a moderately strong wind. The water was open and aircraft altitude ranged from 1100-1900 ft (335-579 m).

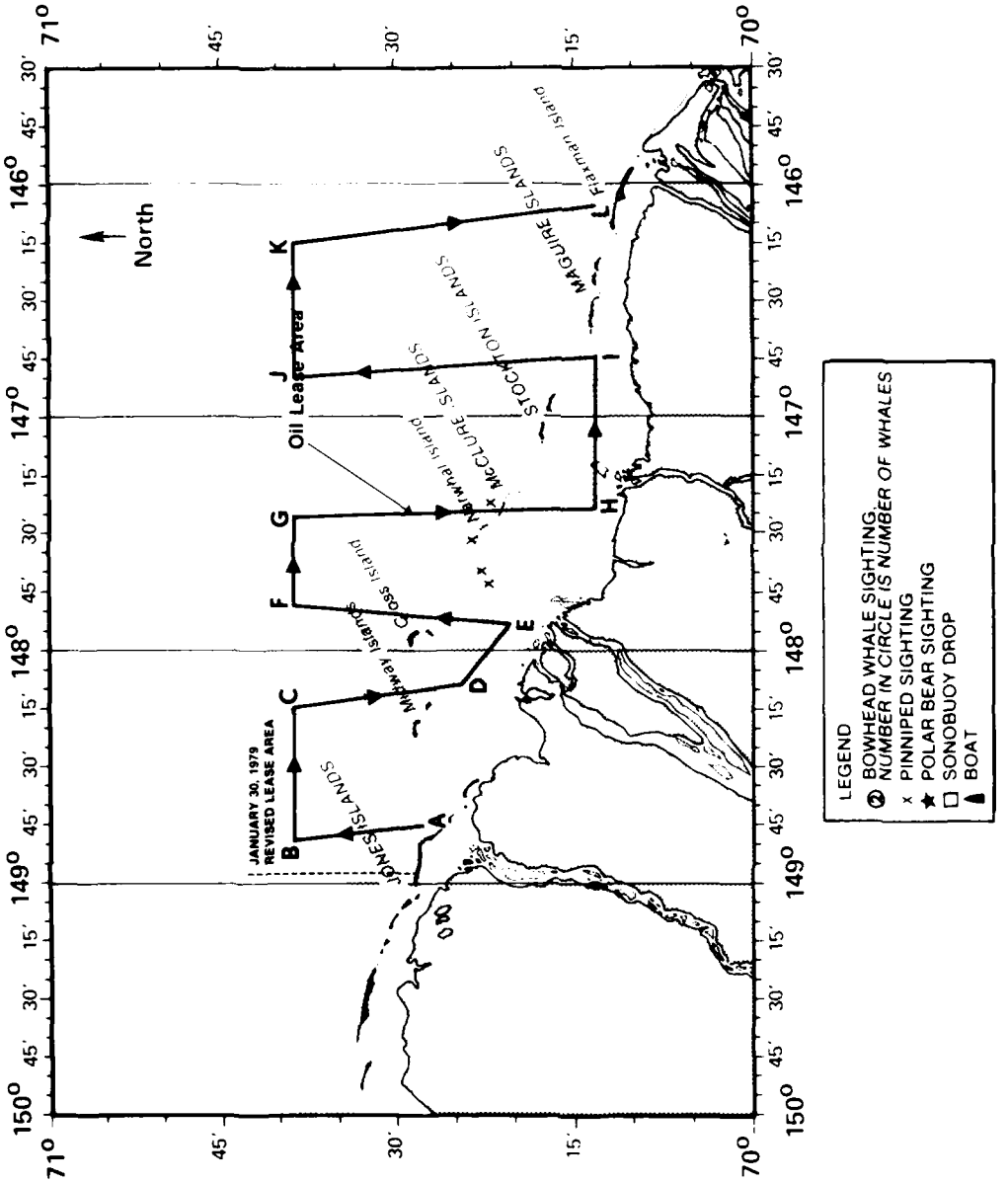
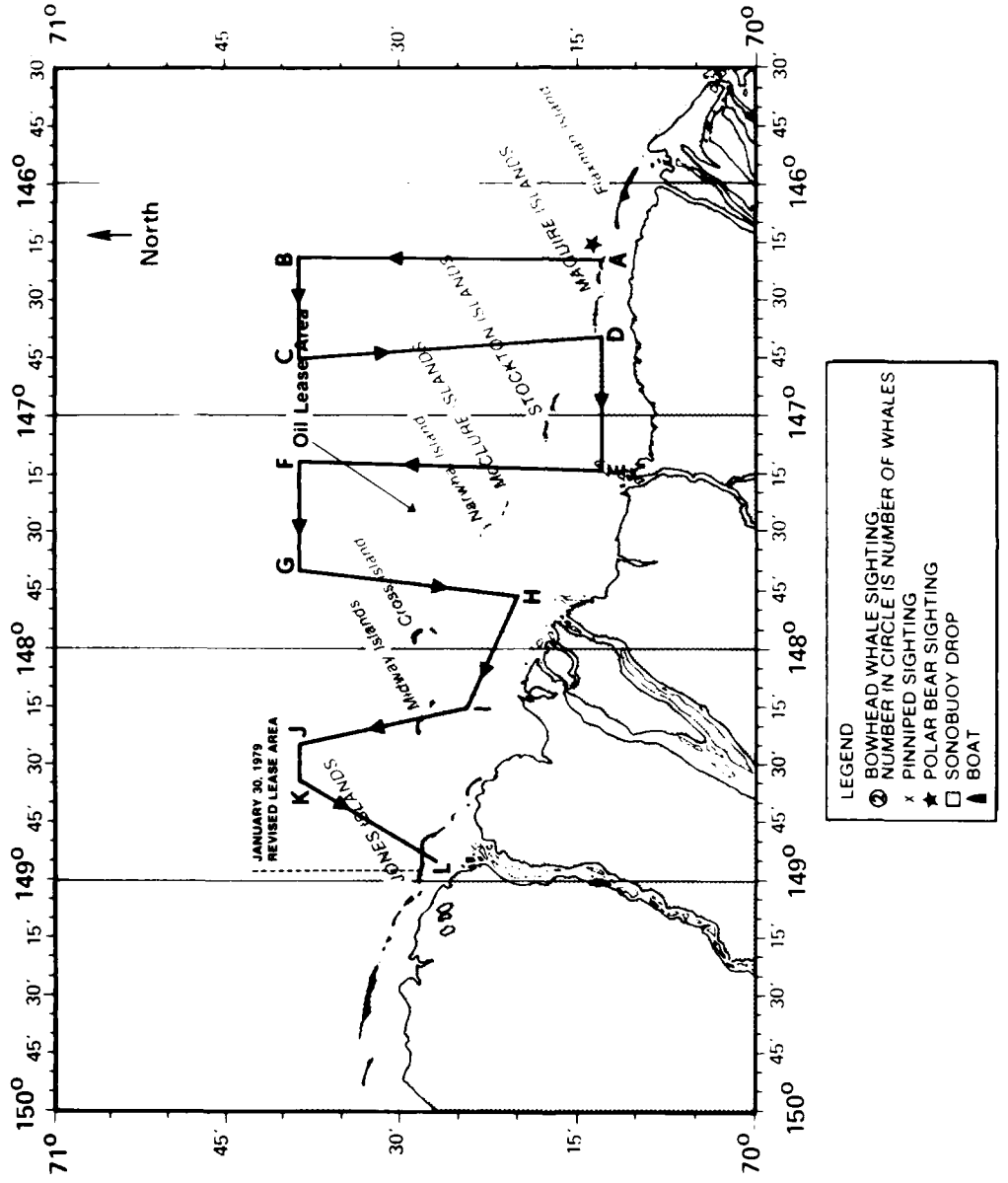
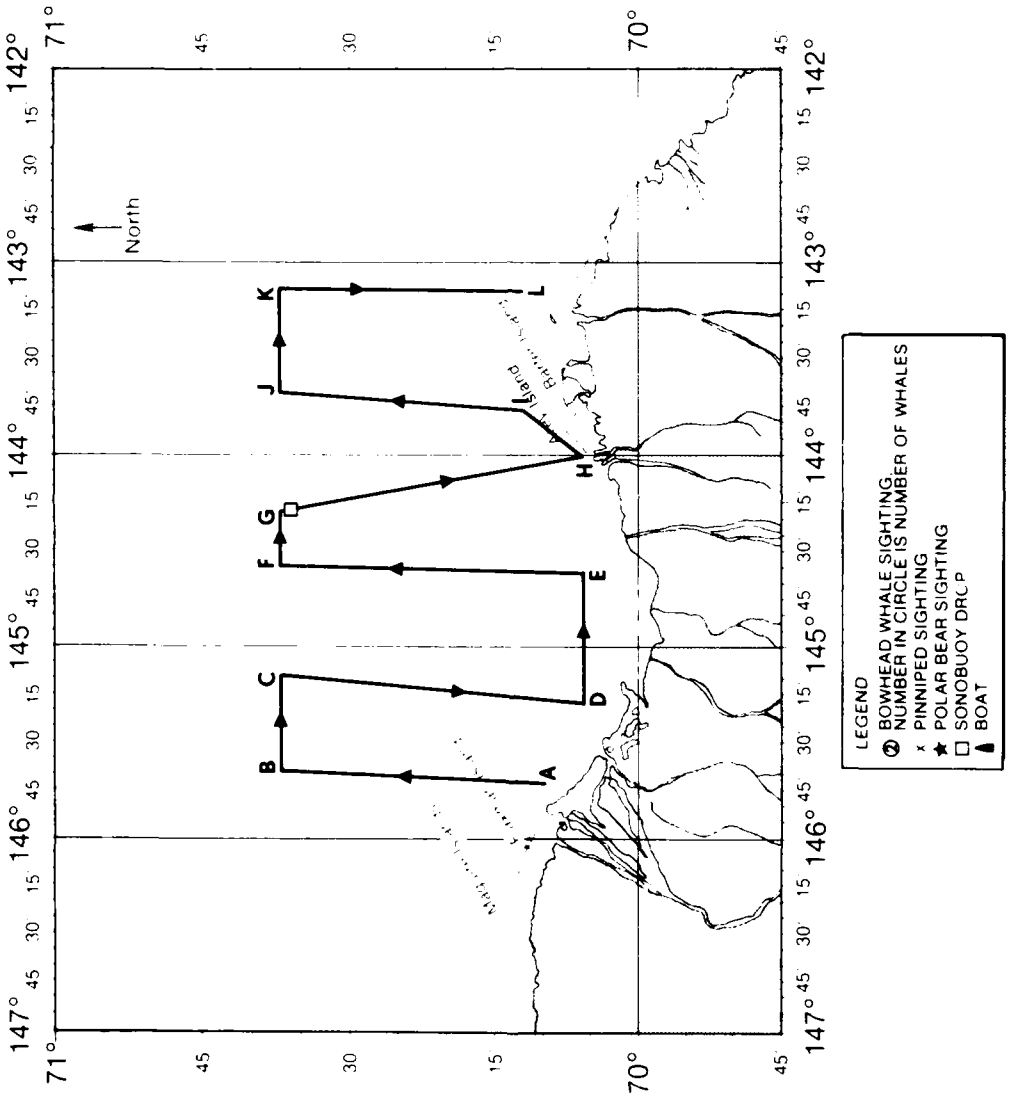


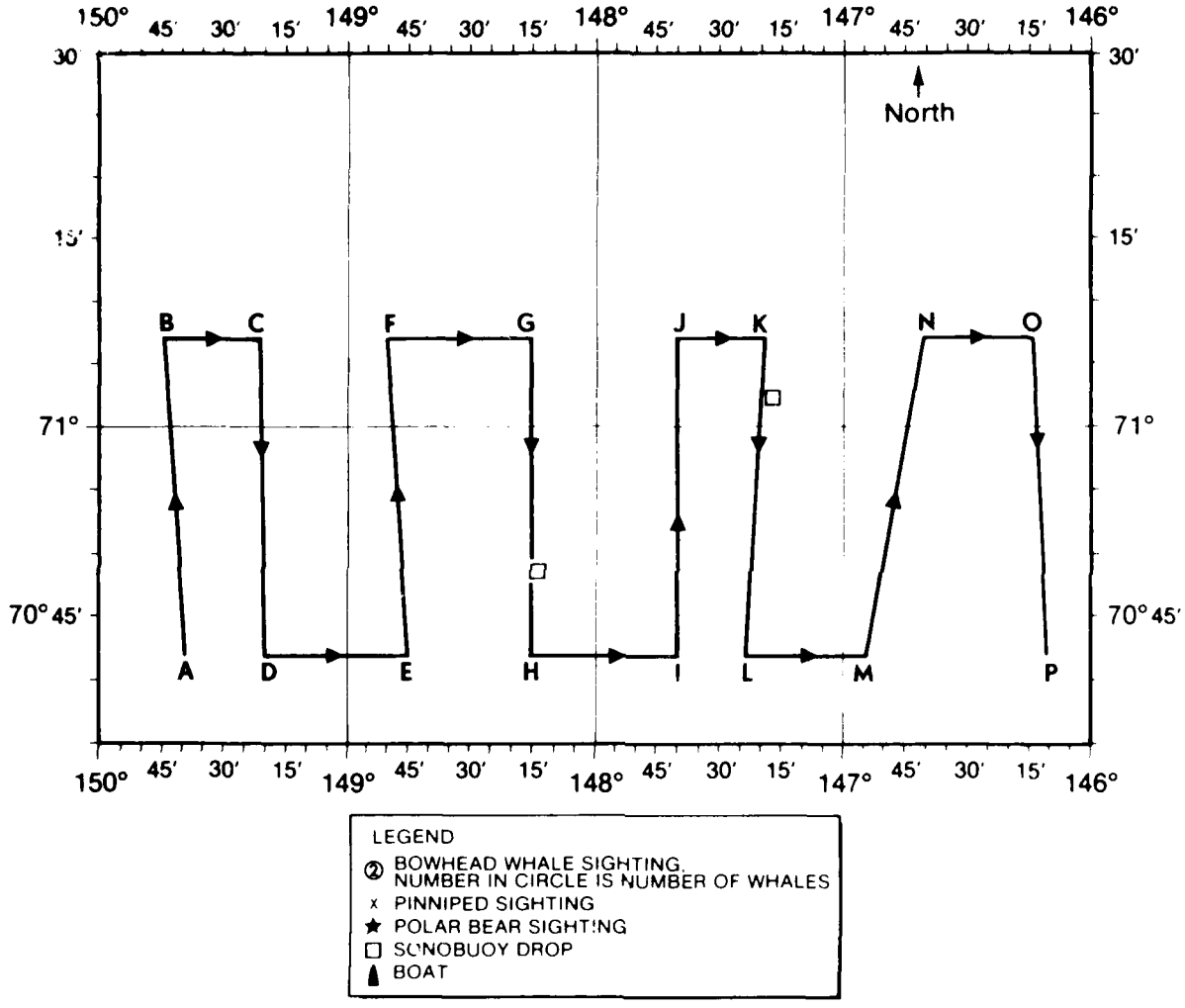

Figure 27, 14 September 1979, Block #1. Four pinniped sightings, for a total of six individuals, one of which was a walrus, were made. Visibility ranged from good to fair under cloudy skies with snow squalls. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 400-1000 ft (122-305 m).



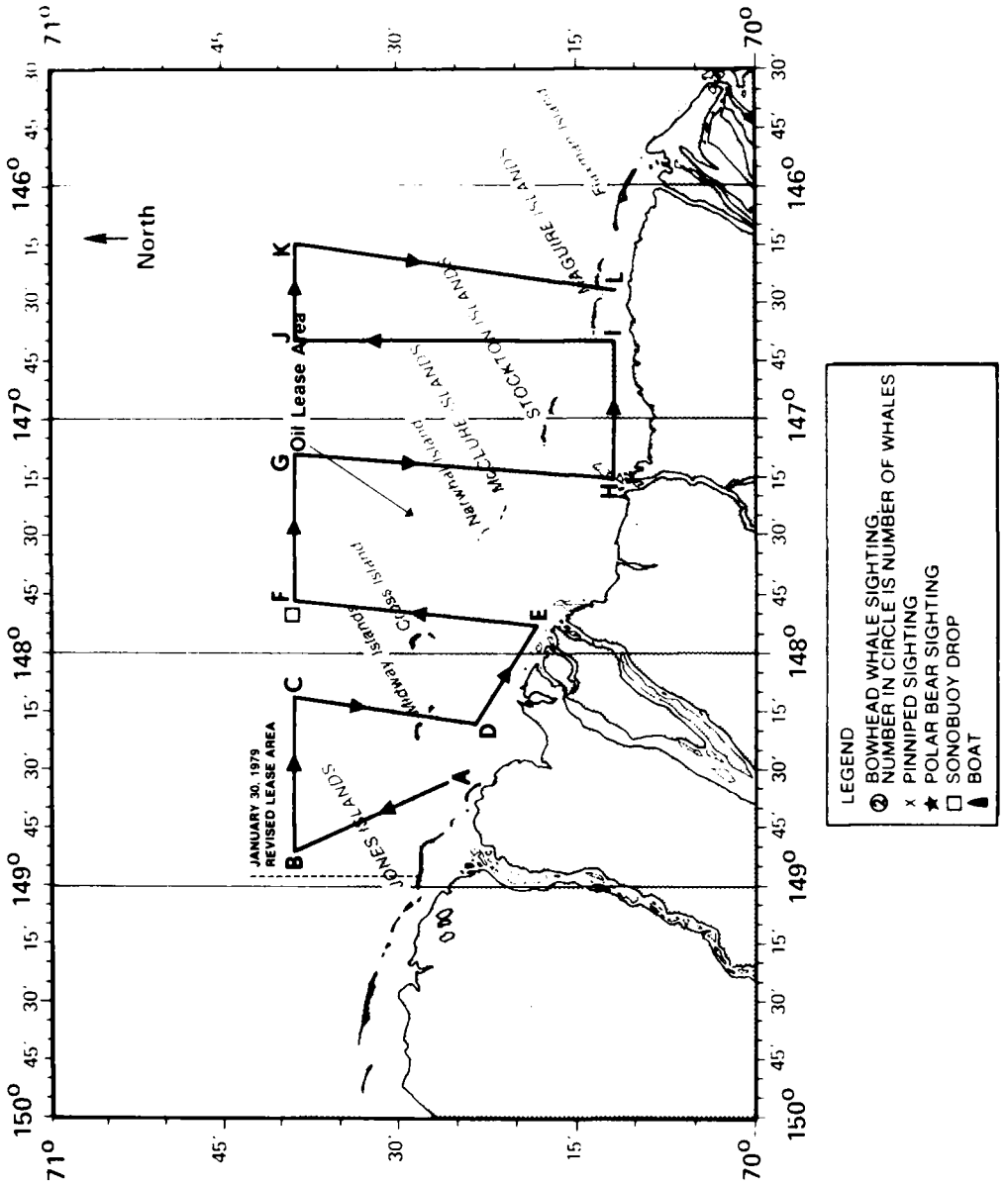

Flight 28, 15 September 1979, Block #1. One polar bear sighting of two individuals was made. Visibility was poor because of overcast skies and light fog with a moderate wind. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 600-800 ft (183-244 m).




Flight 29, 17 September 1979, Block #3. No sightings were made; one sonobuoy was dropped. Visibility was good, the weather calm, and the water mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).




Flight 30, 17 September 1979, Block #2. No sightings; two sonobuoy drops were made. Visibility ranged from good to fair, with overcast skies and snow squalls. The water was mostly open. Aircraft altitude ranged from 500-1200 ft (152-366 m).

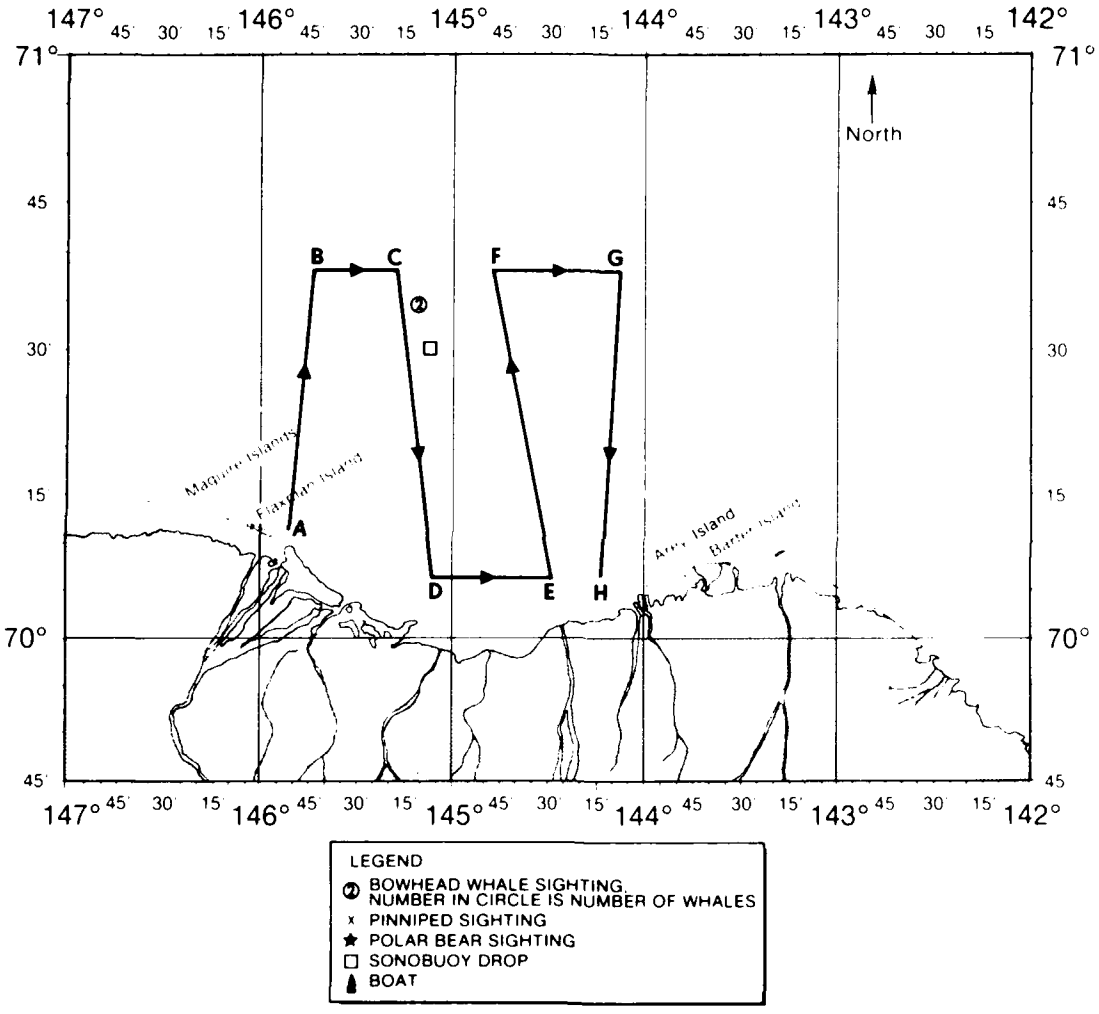



Flight 31, 18 September 1979, Block #1. No sightings; one sonobuoy drop was made. Visibility was good with a light wind. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 900-1500 ft (274-457 m).

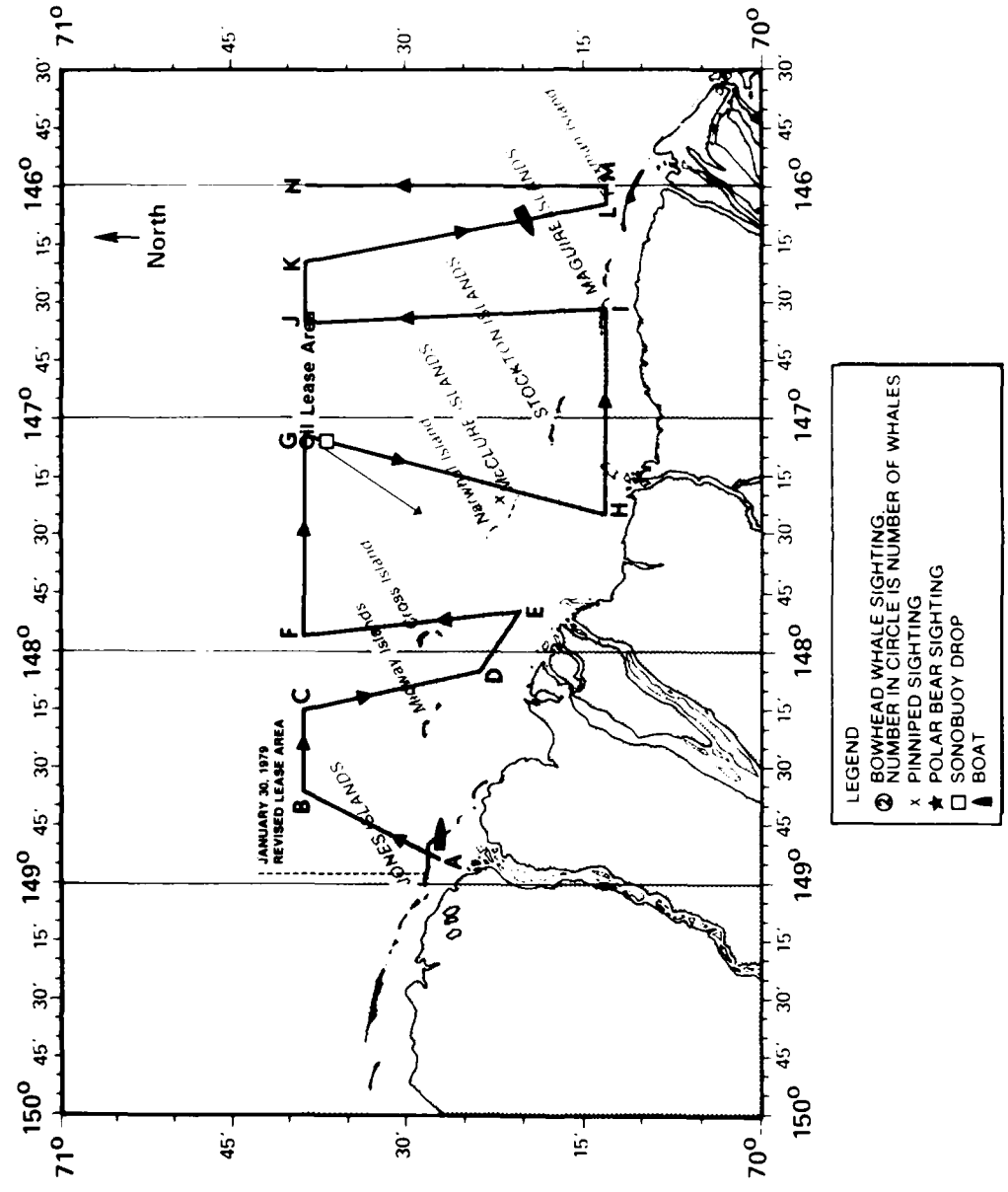
Table B4. Bowhead whale sightings for flight 32, 18 September 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 2 | 70°34'30" | 145°13'42" | – | 10 | 225 | O | | Dove |

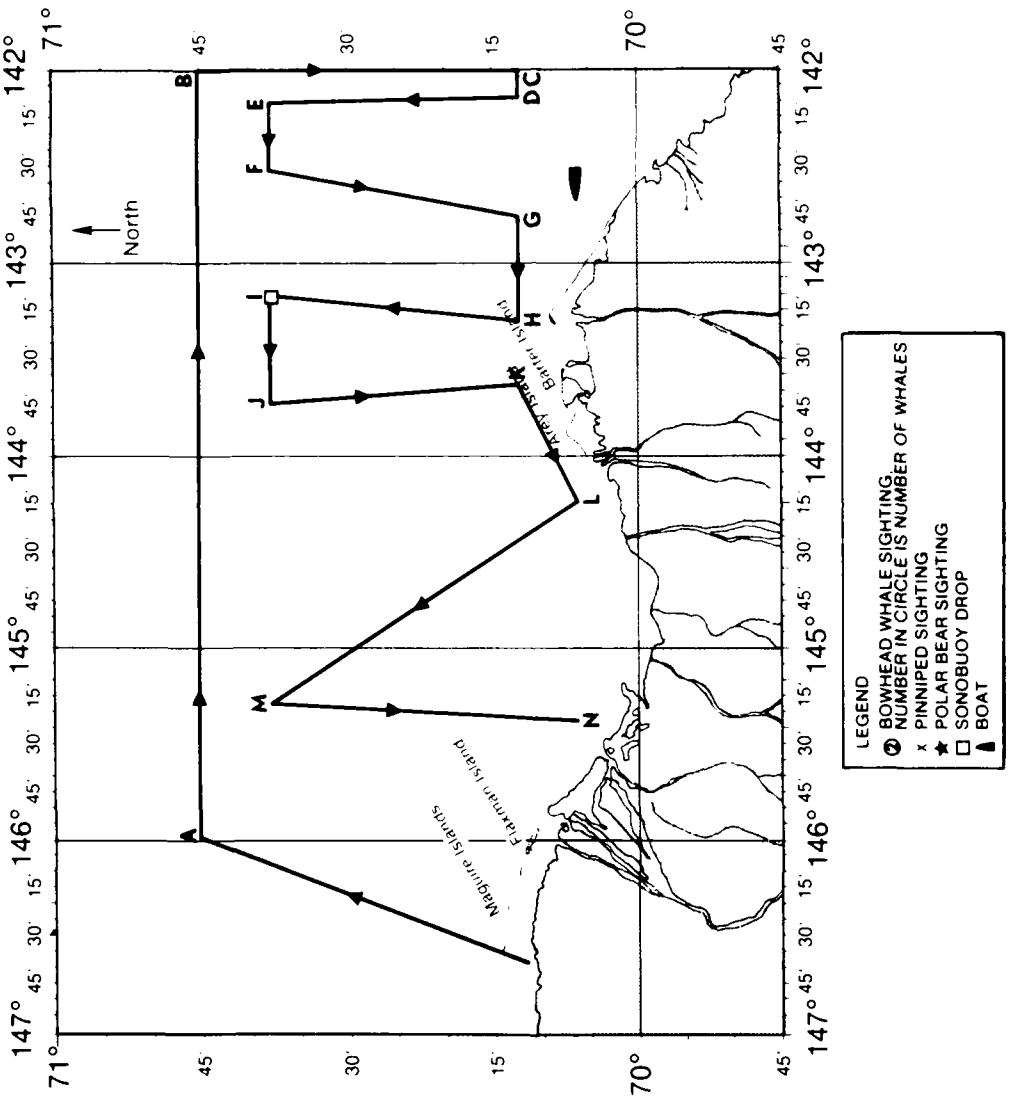
*O – original sighting.



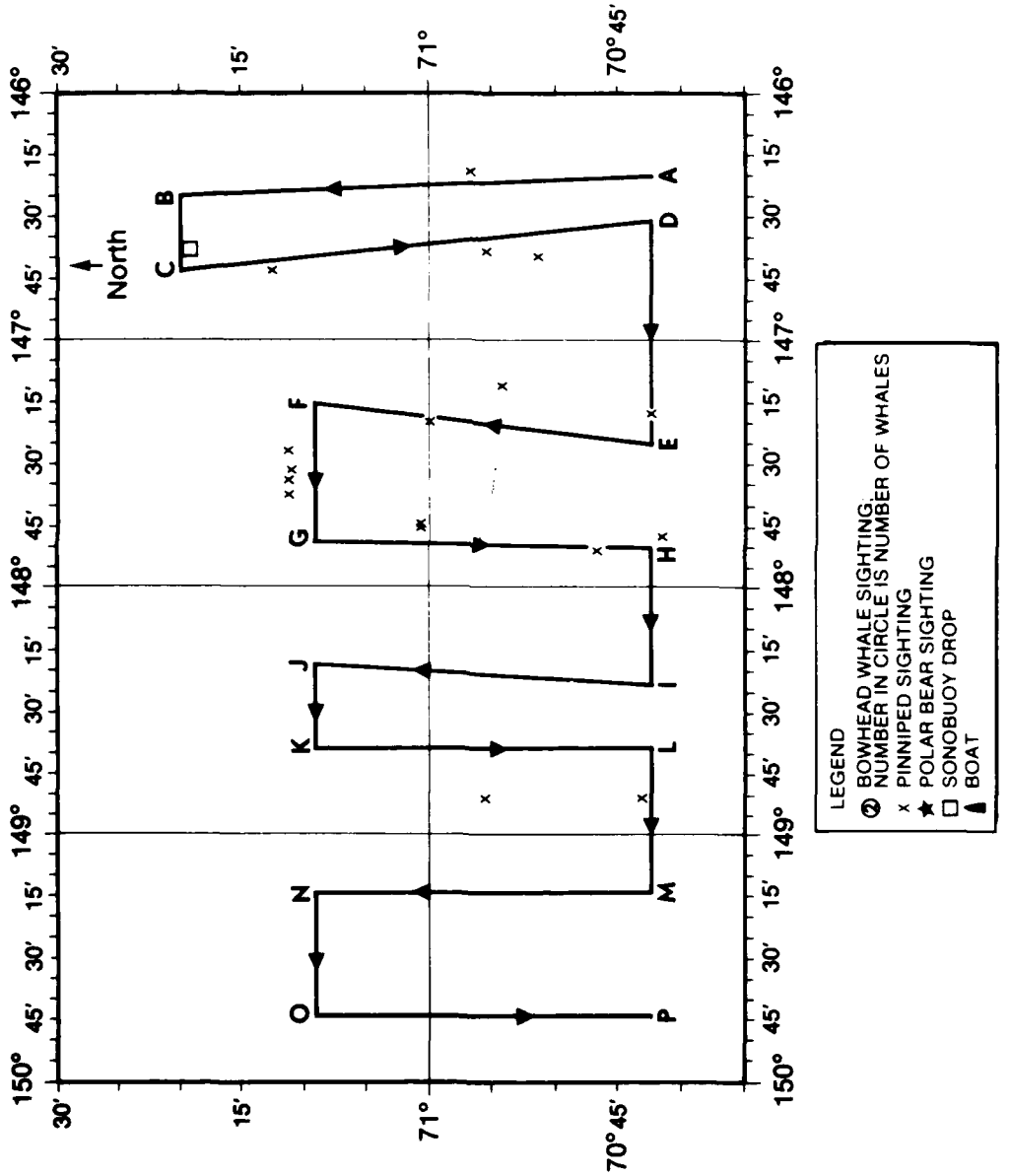

Flight 32, 18 September 1979, Block #3. One bowhead whale sighting of two individuals (table B4), one sonobuoy drop was made. The flight was cut short because of lack of fuel. Visibility was excellent with calm weather, and the water was mostly open. Aircraft altitude ranged from 900-1000 ft (274-305 m).



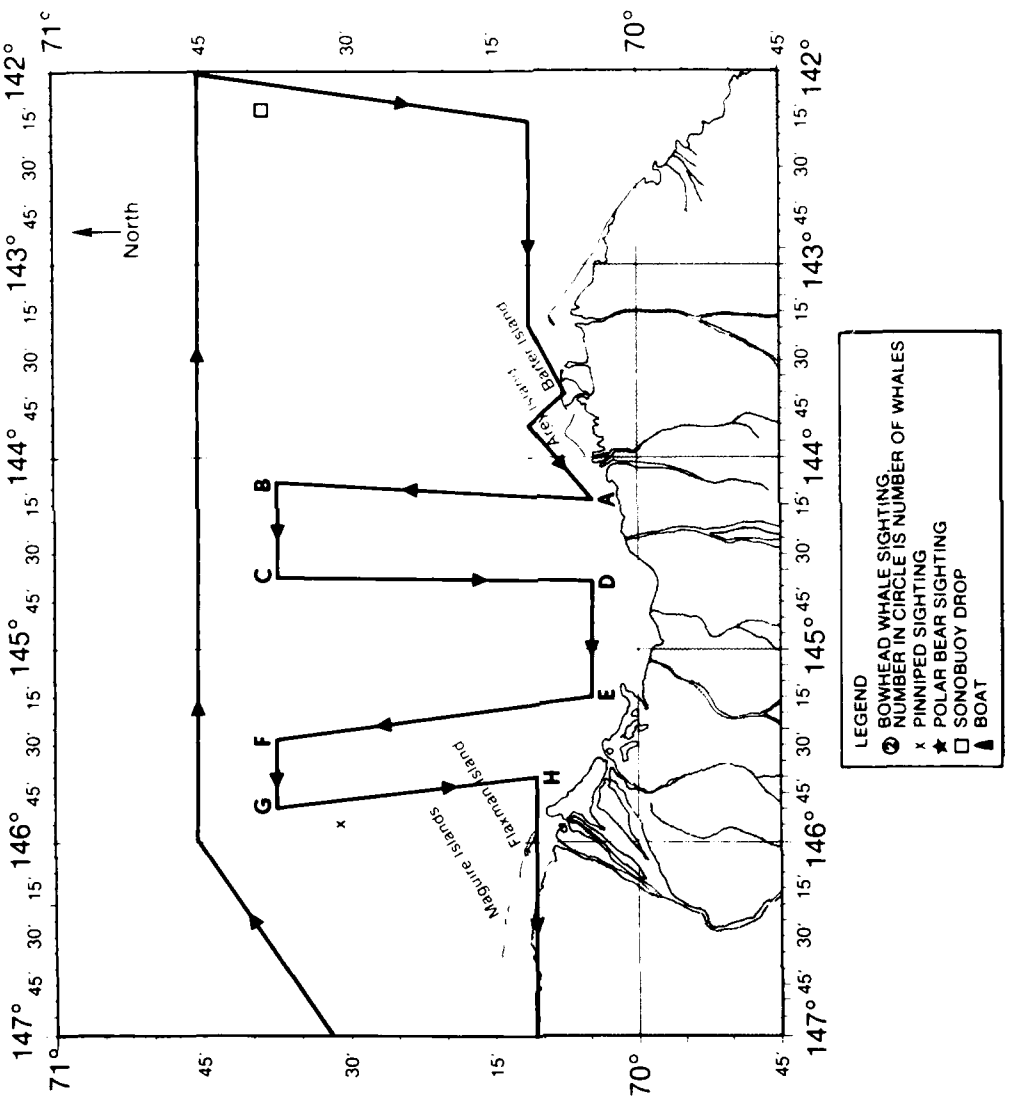

*Flight 33, 19 September 1979, Block #1. One pinniped sighting; one sonobuoy drop was made. Two geophysical boats were noted, and recordings were collected of geophysical sounds. Visibility was excellent, with a light wind. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 100-1500 ft (305-457 m).*




Flight 34, 19 September 1979, Block #3. Five Eskimo whaling boats were seen at the same general area (indicated by the single black boat), and one sonobuoy was dropped. Visibility was excellent, with calm weather. The water was mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).




Flight 35, 20 September 1979, Block #2. Seventeen pinniped sightings for a total of 71 individuals; one sonobuoy drop was made. Visibility was excellent with calm weather. The water was mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).

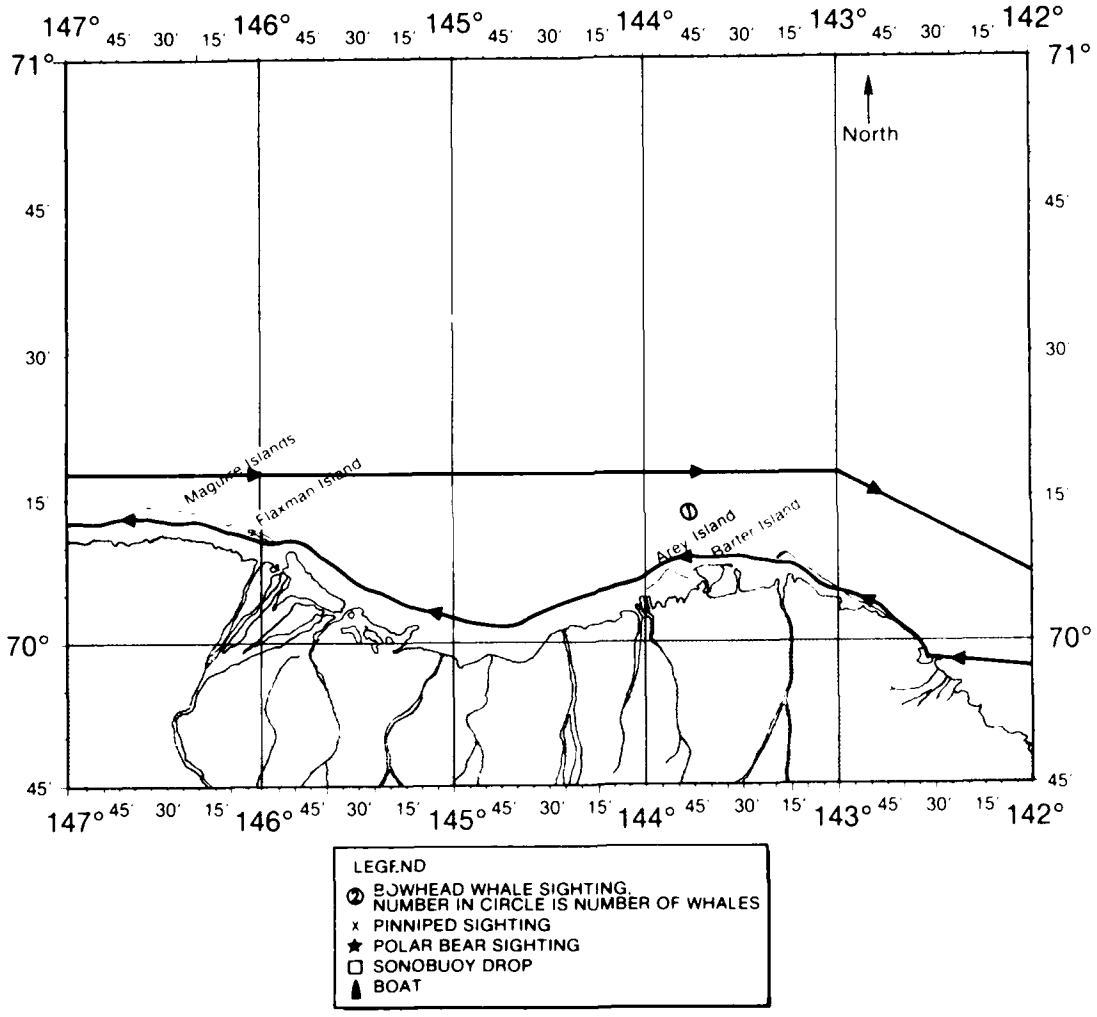



**Flight 36, 23 September 1979, Block #3. One pinniped sighting and one sonobuoy drop were made. Visibility was very good, with some patchy fog present. The water was mostly open. Aircraft altitude ranged from 1300-1500 ft (396-457 m).**

Table B5. Bowhead whale sightings for flight 37-A, 24 September 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°13'06" | 143°47'30" | – | 30 | – | O | | |

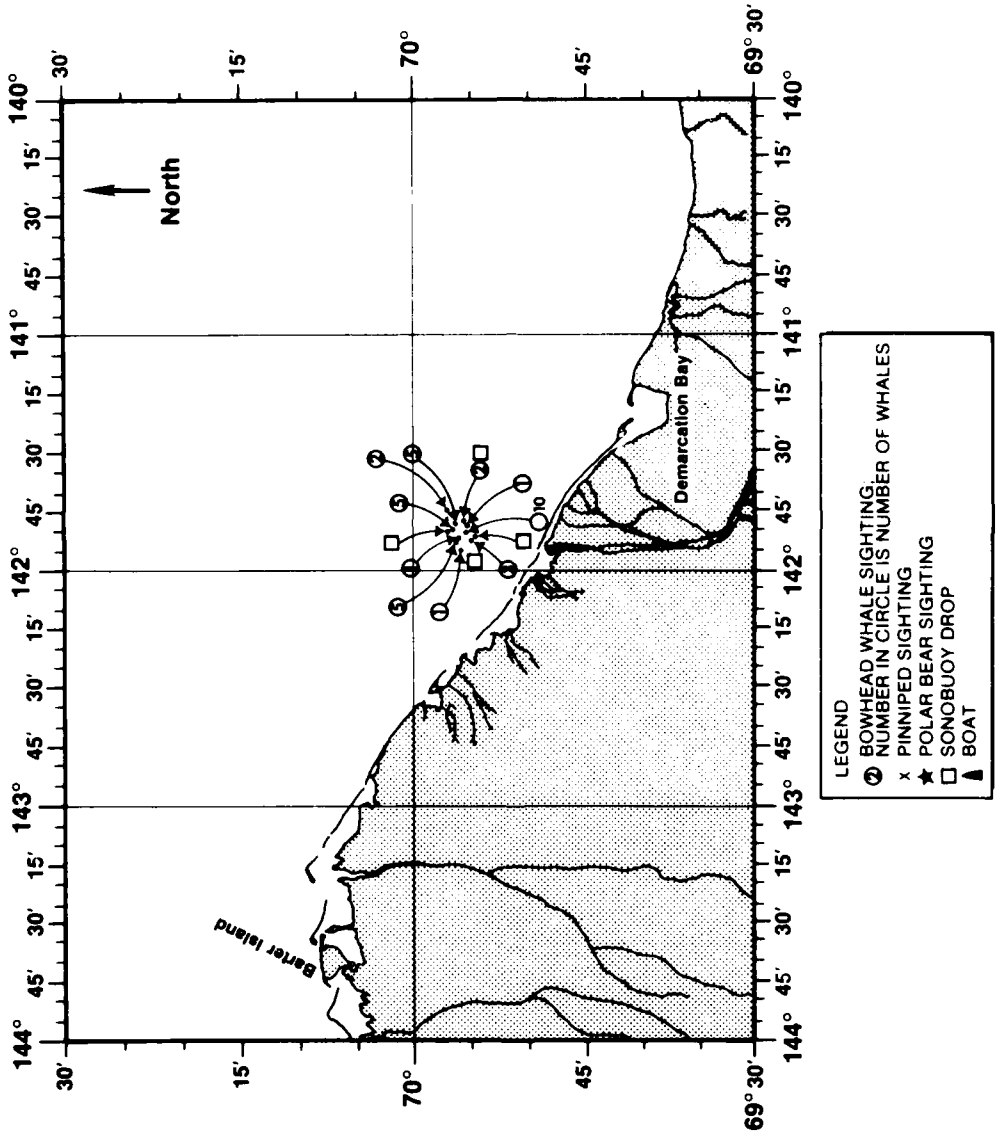
*O – original sighting.



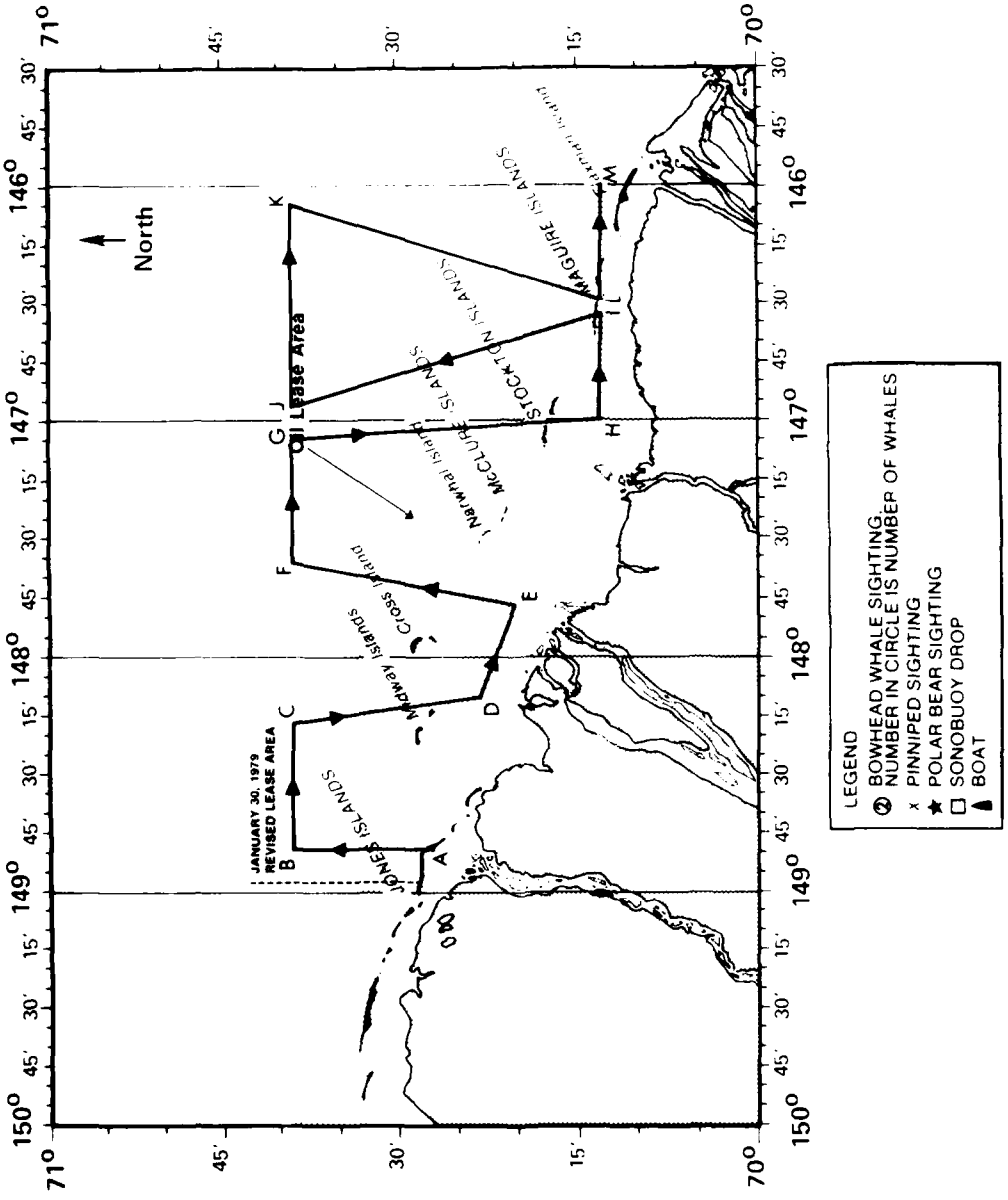

Flight 37-A, 24 September 1979, line transect east to Demarcation Bay and return. One bowhead whale sighting of one individual (table B5) was made on the way to Demarcation Bay. Visibility was very good, with clear weather on three sides and a northern fog bank. The water was mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).

Table B6. Bowhead whale sightings for flight 37-B, 24 September 1979, Demarcation Bay. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 69°56'00" | 141°54'30" | – | – | 135 | | | Dove |
| 5 | 69°52'30" | 141°52'30" | – | – | 90 | | | On surface |
| 2 | 69°55'42" | 141°47'06" | – | – | 270 | | | On surface |
| 5 | 69°56'24" | 141°49'54" | – | – | Milling | | | On surface |
| 5 | 69°56'12" | 141°47'18" | – | – | 5 at 270° | | | On surface |
| 10 | 69°55'24" | 141°50'00" | – | | 6 to 90<br>4 to 270 | | | On surface |
| 2 | 69°57'00" | 141°44'00" | | | 135 | | | On surface |
| 3 | 69°55'00" | 141°52'00" | | – | 135 | | | On surface |
| 1 | 69°55'12" | 141°47'00" | – | – | 90 | | | Dove |
| 1 | 69°56'06" | 141°51'30" | | – | 270 | | | On surface |




Flight 37-B, 24 September 1979, Demarcation Bay, continuation of flight 37-A. Ten bowhead whale sightings, for a total of 35 individuals (table B6); four sonobuoy drops were made. Visibility was good with clear weather except for a fog bank to the north. The water was open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).




Flight 38, 24 September 1979, Block #1. No sightings were made. Visibility was good to fair, with overcast skies and a strong wind. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 1000-1500 ft (305-457 m).

Table B7. Bowhead whale sightings for flight 39-A, 26 September 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 2 | 70°23'06" | 146°32'30" | 1500/457 | 36 | 315 | O | 0.250/0.463 | Dove immediately, one following the other closely. Geophysical sounds recorded in presence of these whales. Possible whale vocalizations also recorded; see detailed description |

*O – original sighting.

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AERIAL SURVEYS OF BOWHEAD WHALES, NORTH SLOPE, ALASKA.(U)
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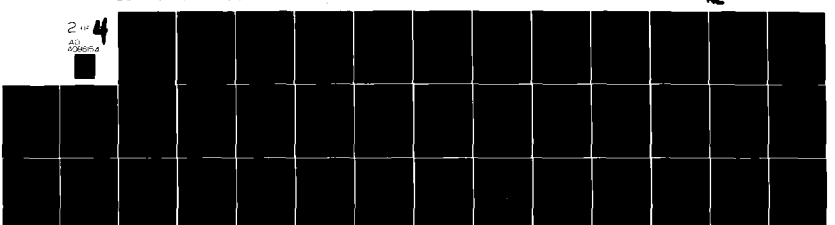

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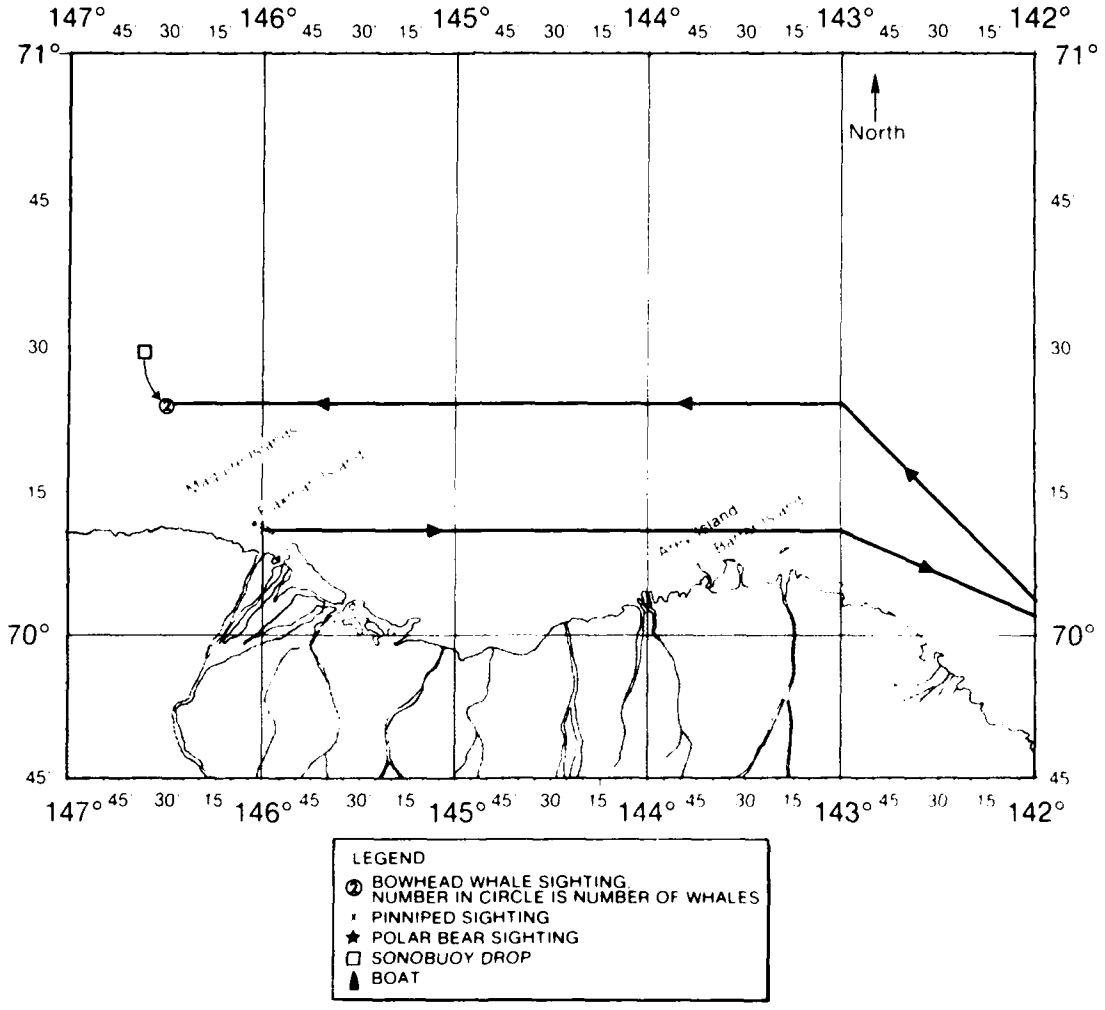
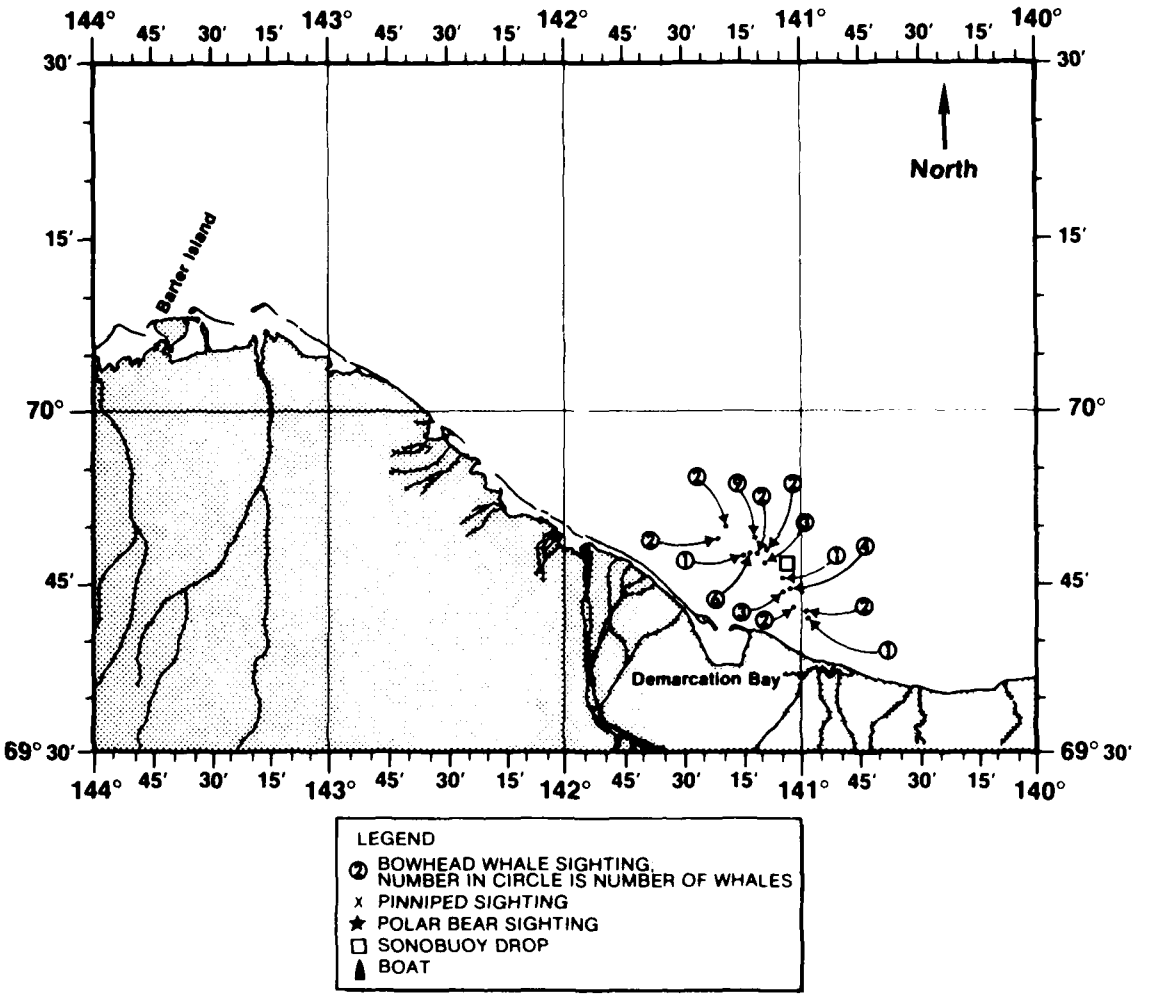



Flight 39-A, 26 September 1979, line transect east to Demarcation Bay and return. One bowhead whale sighting of two individuals was made (table B7) on the return leg. Visibility was excellent, with a light northeast wind. The water was mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).

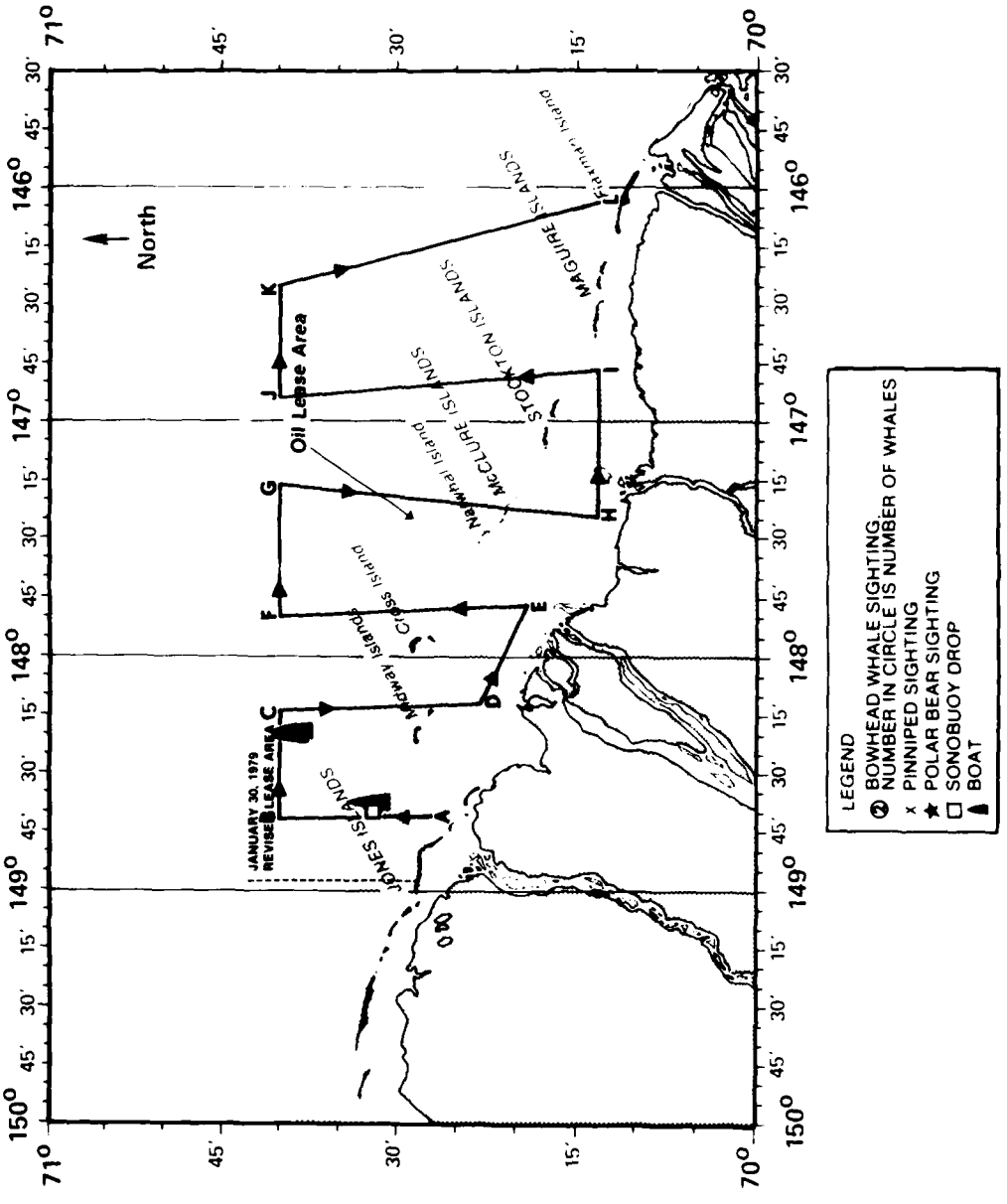
Table B8. Bowhead whale sightings for flight 39-B, 26 September 1979, Demarcation Bay. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft/m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi/km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 2 | 69°49'48" | 141°18'24" | 1500/457 | - | 90 | O | | On surface |
| 9 | 69°49'00" | 141°11'12" | 1300/396 | - | 2 to 180<br>3 to 270<br>4 to 90 | O | | On surface |
| 2 | 69°47'30" | 141°07'48" | 1300/396 | – | 90 | O | | On surface |
| 4 | 69°44'18" | 141°02'24" | 1200/366 | | | O | | Lying on surface |
| 2 | 69°42'00" | 140°58'42" | 1200/366 | - | 90 | O | | On surface |
| 3 | 69°44'18" | 141°04'12" | 1000/305 | -- | 1 to 90<br>1 to 180<br>1 to 270 | O | | On surface |
| 1 | 69°47'24" | 141°14'54" | 1000/305 | – | 225 | O | | On surface |
| 3 | 69°46'48" | 141°08'30" | 1000/305 | - | 2 to 225<br>1 to 180 | O | | On surface |
| 2 | 69°43'00" | 141°02'06" | 1000/305 | - | 1 to 270<br>1 to 0 | O | | On surface |
| 1 | 69°41'54" | 140°57'54" | 1000/305 | - | 90 | R | | On surface |
| 1 | 69°45'30" | 141°04'54" | 1000/305 | - | 315 | O | | On surface |
| 2 | 69°47'36" | 141°10'30" | 1000/305 | | 90 | R | | On surface |
| 6 | 69°47'42" | 141°12'30" | 1200/366 | – | 270 | O | | On surface |
| 2 | 69°49'00" | 141°21'48" | 1600/488 | - | 1 to 225<br>1 to 270 | O | | On surface |

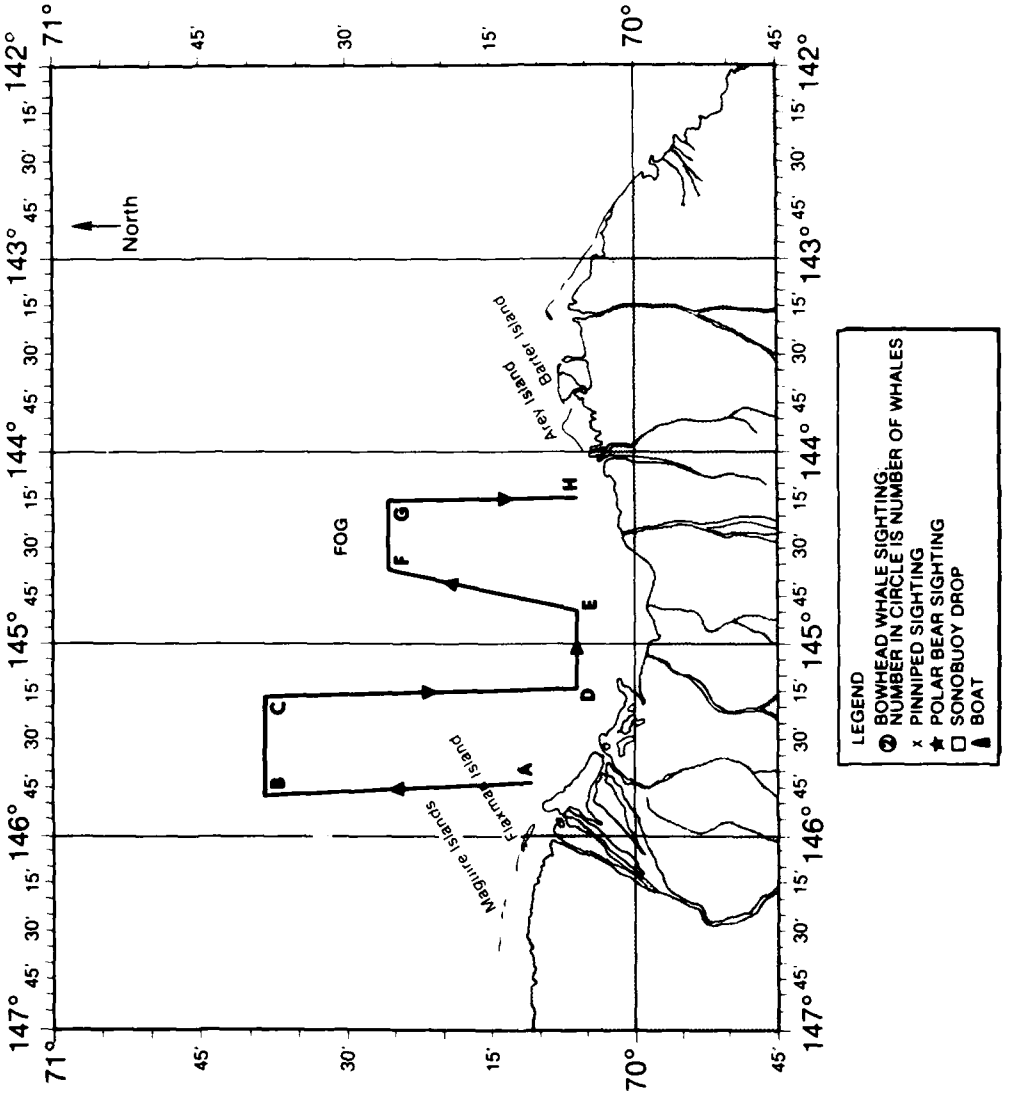
*O – original sighting.
R – possible resighting.




Flight 39-B, 26 September 1979, Demarcation Bay. Fourteen bowhead whale sightings, for a total of 40 individuals (table B8), were made; one sonobuoy was dropped. Visibility was excellent, with a light northeast wind. The water was mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).




Flight 40, 26 September 1979, Block #1. Two geophysical boats were seen; one sonobuoy drop was made. No other sightings were made on this flight; however, an earlier flight (36-A, same day) saw two bowhead whales at the east end. Visibility was good, with skies becoming overcast. Strip ice was present along the northern edge of the barrier islands. Aircraft altitude ranged from 1000-1500 ft (305-457 m).

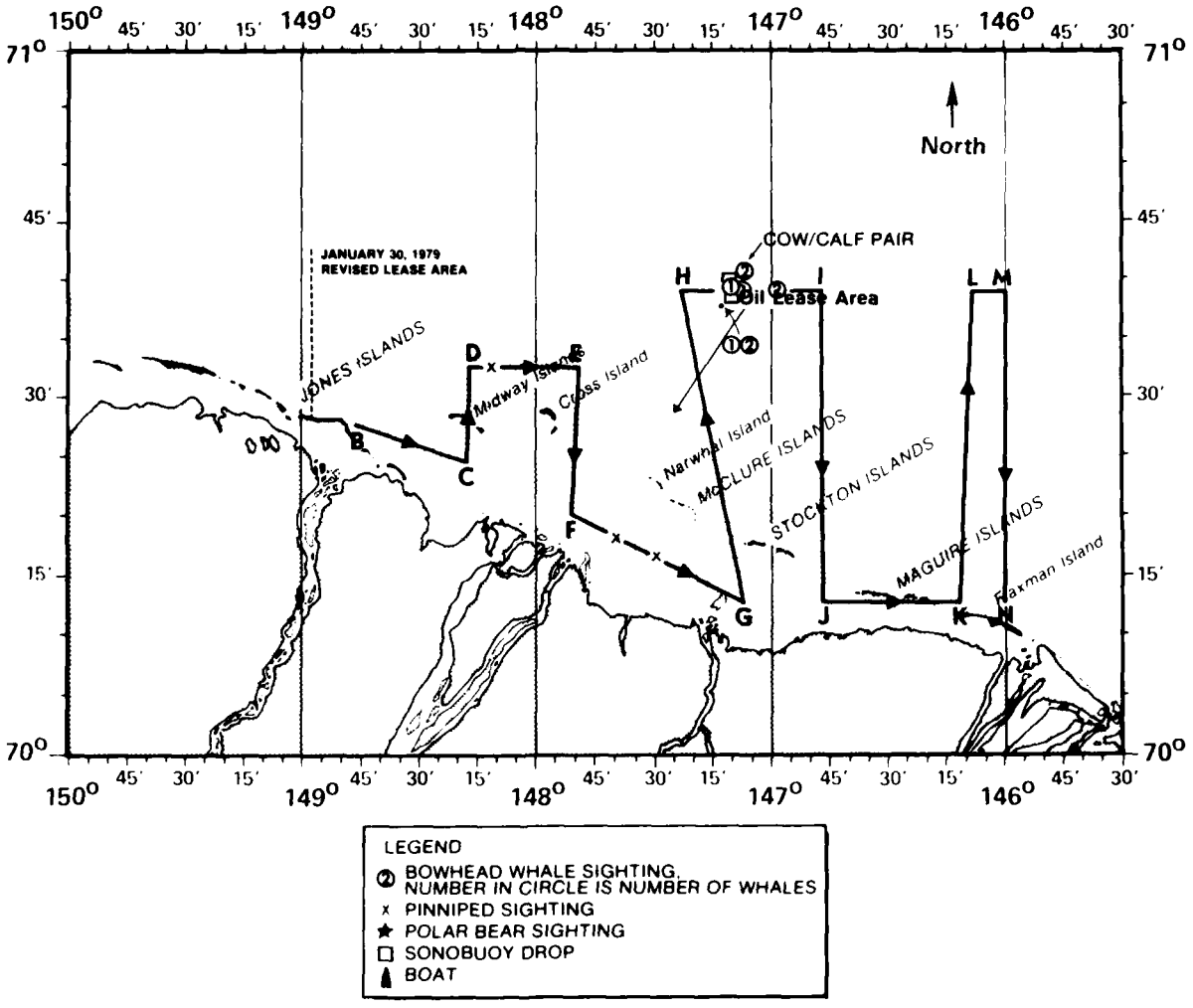



Flight 41, 26 September 1979, Block #3. No sightings were made and the flight was terminated because of imminent fuel shortage. Visibility was good under overcast skies, with a light wind. The water was mostly open. Aircraft altitude ranged from 1000-1500 ft (305-457 m).

Table B9. Bowhead whale sightings for flight 42, 8 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°37'18" | 147°14'36" | 400/122 | 30 | 270 | O | 0.403/0.747 | Was lying stationary in the water at a 45° angle with rostrum in the air, pointing west. |
| 2 | 70°37'24" | 147°14'24" | – | – | 270 | R | | |
| 2 | 70°39'00" | 146°58'24" | 500/152 | 32 | | | 0.102/0.189 | |
| 1 | 70°39'06" | 147°07'00" | – | – | 270 | O | | |
| 2 | 70°40'54" | 147°07'12" | – | – | 270 | O | | A large cow with a small calf. |
| 1 | 70°39'30" | 147°10'30" | – | 20 | – | O | | |

*O – original sighting.
R – possible sighting.

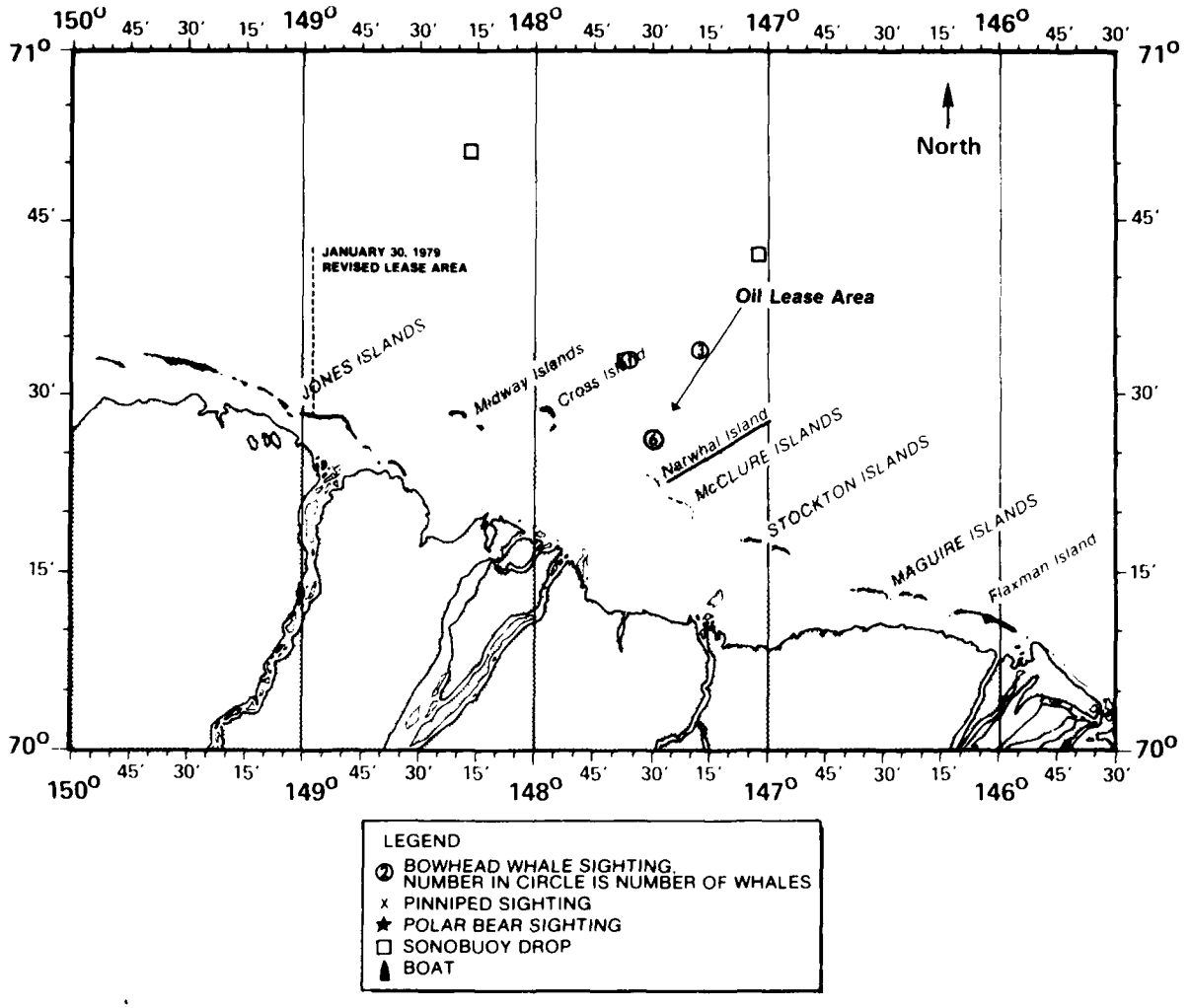



Flight 42, 8 October 1979, Block #1. Six bowhead whale sightings, for a total of nine individuals, including a large cow with a small calf (table B9); three pinniped sightings of three individuals; two sonobuoy drops were made. Visibility was good under a low cloud ceiling and strong northeast wind, which caused a high sea state. Landfast ice edged with pancake and grease ice extended from shore halfway to the barrier islands; the remaining water was still open. Aircraft altitude ranged from 250-500 ft (76-152 m).

Table B10. Bowhead whale sightings for flight 43, 11 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 3 | 70°33'48" | 147°18'00" | 1000/305 | – | – | O | | Whales milling about in all directions; frequent diving; at least two whales dove with their flukes thrown clear of the water. The sea was brown with a reddish tinge and had streaks of blue water. Suspect that whales were feeding. |
| 1 | 70°32'48" | 147°36'00" | 450/137 | 40 | – | O | 0.061/0.113 | |
| 6 | 70°26'00" | 147°30'00" | 380/116 | – | Milling | O | | |

*O – original sighting.

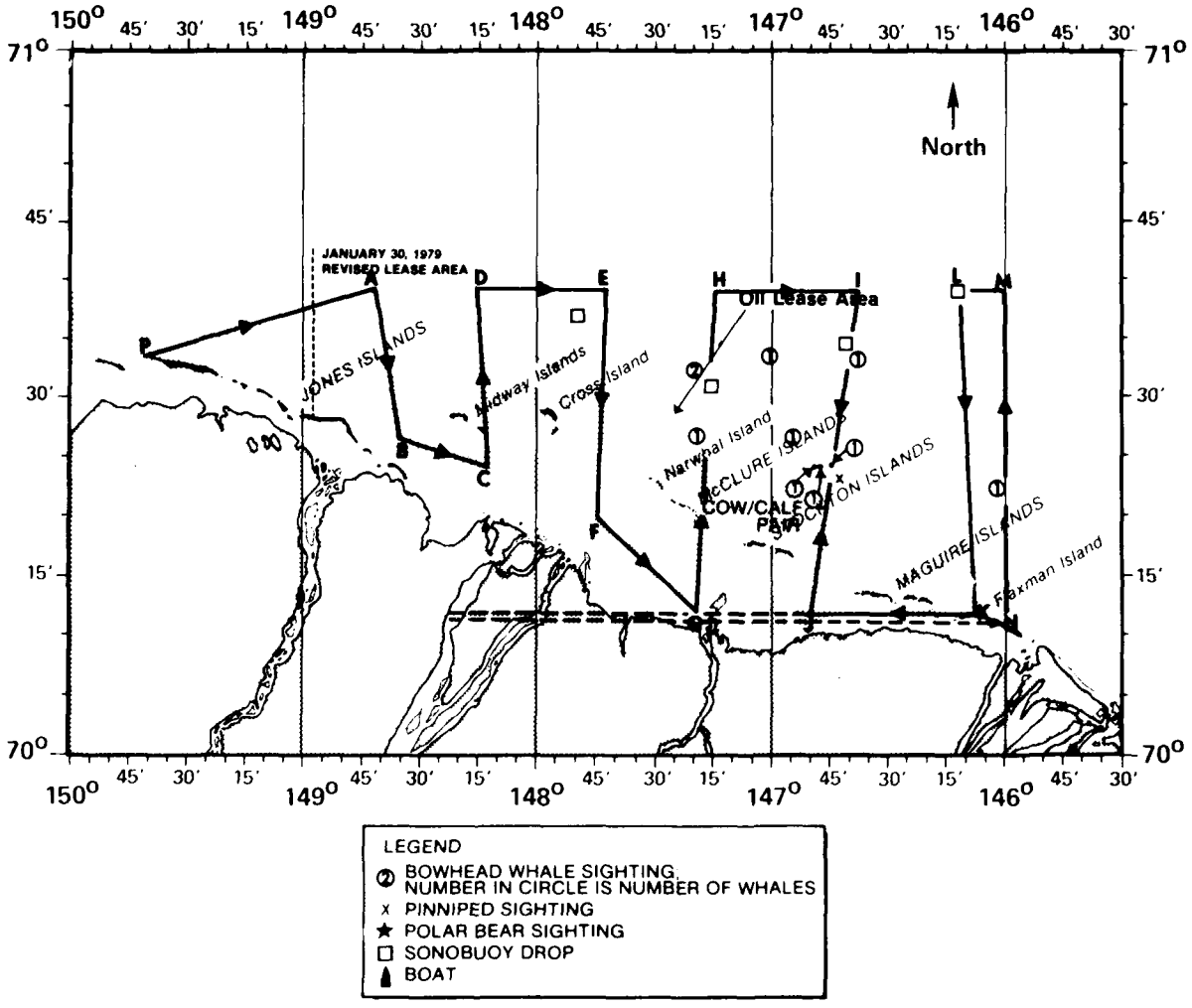



Flight 43, 11 October 1979, Block #1. A formal transect was aborted, and sighting positions are approximate because of navigational system failures, with the exception of a total of six bowhead whales (table B10) seen in an area 2.5 miles northwest of Narwhal Island. This position was confirmed by the pilot. Narwhal Island is the only island in the area with both a tower and large, bright orange buildings, all of which were positively identified. Visibility was good, with cloudy, overcast skies, and water was mostly open with some grease ice forming. Aircraft altitude ranged from 400-1000 ft (122-305 m).

Table B11. Bowhead whale sightings for flight 44, 13 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 2 | 70°32'18" | 147°19'30" | 600/183 | – | – | O | | About 1 octate ice, but water mostly near whales, recording made. |
| 1 | 70°33'00" | 146°39'54" | 600/183 | – | – | O | | |
| 1 | 70°24'42" | 146°45'30" | 600/183 | 6 | 180 | O | 0.903/1.673 | Whales seen in 2 to 3 octates of slush ice. |
| 1 | 70°24'42" | 146°45'30" | 600/183 | 15 | – | O | 0.332/0.615 | |
| 1 | 70°24'18" | 146°48'36" | – | 18 | 180 | O | | Seen at surface, about 20 ft long; suspect a large calf. |
| 1 | 70°24'06" | 146°48'36" | – | – | – | O | | A huge whale which surfaced near the large calf 4 minutes later (conclude that these two whales are cow and calf pair). |
| 1 | 70°22'00" | 146°02'12" | 600/183 | 10 | – | O | 0.523/0.970 | Seen in about 5 octates of slush ice in opening formed when whale surfaced. |
| 1 | 70°33'06" | 147°00'48" | 600/183 | 24 | – | O | 0.186/0.344 | Dove initially; when seen again the whale had surfaced to blow and as the airplane circled back, the whale sank down vertically. |
| 1 | 70°27'12" | 147°19'18" | 600/183 | 15 | 180 | O | 0.332/0.615 | Saw track in slush ice first, then whale blew. |

*O – original sighting.

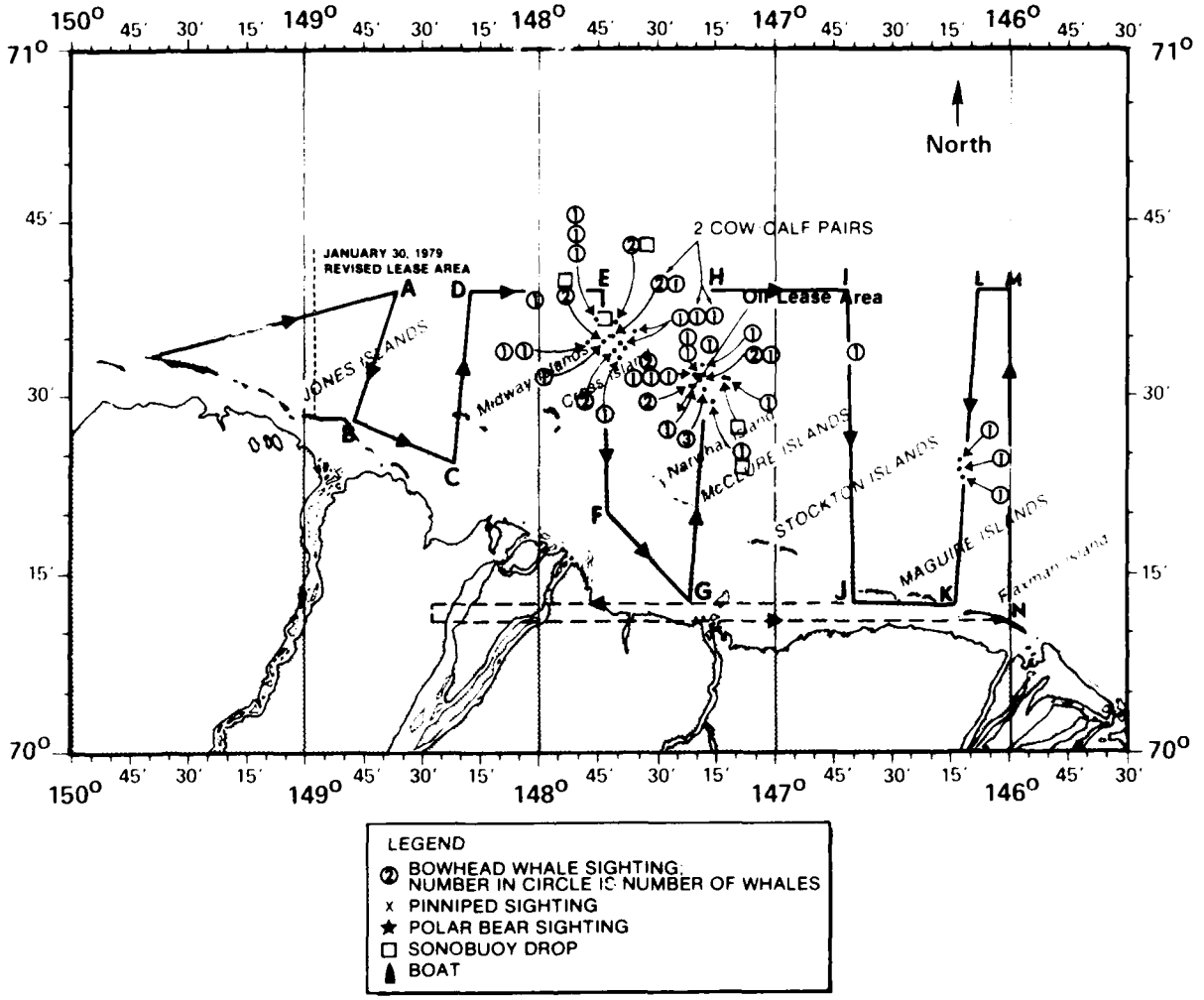



Flight 44, 13 October 1979, Block #1. Nine bowhead whale sightings for a total of 10 whales including a cow with a big calf (table B11); one pinniped sighting; four sonobuoy drops were made. Dashed line indicates a fuel break at point J. Transect was resumed at point N after refueling and was run backward to end at point I. Visibility ranged from good to poor under low overcast and haze. Slush and grease ice are present farther north of the barrier islands. Aircraft altitude ranged from 500-900 ft (152-274 m).

Table B12. Bowhead whale sightings for flight 45, 14 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No. of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, nu /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°38'30" | 148°00'30" | 500/152 | 13 | | O | 0.327/0.605 | Dove in open track in slush ice |
| 1 | 70°35'00" | 147°42'00" | | | 90 | O | | |
| 2 | 70°35'00" | 147°42'42" | 800/244 | 34 | 90 | O | | Cow and small calf. |
| 1 | 70°34'24" | 147°39'54" | 1200/366 | 32 | 71 | O | | |
| 2 | 70°34'24" | 147°39'54" | 1200/366 | 23 | 71 | O | | Cow and calf |
| 2 | 70°33'54" | 147°41'18" | | - | - | O | | Big adults just hanging in the water. |
| 1 | 70°34'36" | 147°48'06" | | - | - | O | | Made a 1/2 circle track in slush. |
| 1 | 70°34'36" | 147°48'06" | | - | 252 | O | | |
| 1 | 70°33'12" | 147°40'00" | 600/183 | 48 | 153 | O | | |
| 1 | 70°34'36" | 147°44'12" | 700/213 | 16 | 323 | O | | |
| 1 | 70°36'24" | 147°45'48" | 900/274 | - | - | O | | |
| 1 | 70°36'24" | 147°45'48" | 900/274 | 19 | 108 | O | | Part of a loosely scattered group of 3. |
| 1 | 70°36'24" | 147°45'48" | 900/274 | 18 | 133 | O | | Part of a loosely scattered group of 3. |
| 2 | 70°36'12" | 147°40'18" | 700/213 | 10 | 153 | O | | Part of a loosely scattered group of 3. |
| 1 | 70°34'00" | 147°38'00" | 700/213 | 29 | 135 | O | | |
| 2 | 70°33'00" | 147°33'00" | 700/213 | 12 | 168 | O | | Both big, one following the other very closely. |
| 1 | 70°35'30" | 147°36'00" | 700/213 | - | - | O | | |
| 1 | 70°34'00" | 147°17'18" | 600/183 | 18 | 33 | O | 0.304/0.563 | |
| 1 | 70°32'42" | 147°18'42" | 600/183 | 12 | 171 | O | 0.464/0.860 | |
| 1 | 70°31'30" | 147°19'06" | 600/183 | 60 | 135 | O | | |
| 1 | 70°31'18" | 147°19'12" | 600/183 | 42 | 315 | R | | |
| 1 | 70°30'42" | 147°20'48" | 600/183 | 10 | - | O | | |
| 1 | 70°31'12" | 147°11'36" | 600/183 | 34 | 133 | O | | |
| 1 | 70°33'36" | 146°40'00" | 1000/305 | 38 | 121 | O | 0.211/0.390 | |
| 1 | 70°23'00" | 146°11'48" | 800/244 | 20 | 344 | O | 0.362/0.670 | |
| 1 | 70°23'42" | 146°12'30" | 800/244 | 25 | 164 | O | 0.282/0.523 | |
| 1 | 70°24'30" | 146°12'36" | 800/244 | 10 | 164 | O | 0.747/1.383 | |
| 1 | 70°29'24" | 147°15'30" | 1400/427 | - | 003 | O | | |
| 1 | 70°30'36" | 147°17'36" | - | - | - | O | | |
| 2 | 70°31'24" | 147°18'54" | 1100/335 | - | - | R | | Both stationary in water. |
| 1 | 70°31'42" | 147°20'12" | 700/213 | 39 | 31 | R | | Part of loosely scattered group. |
| 1 | 70°31'42" | 147°20'12" | 700/213 | 32 | 173 | R | | Part of loosely scattered group. |
| 1 | 70°31'42" | 147°20'12" | 700/213 | 21 | - | R | | Part of loosely scattered group. |
| 1 | 70°32'00" | 147°17'54" | 700/213 | 12 | 113 | O | | |
| 2 | 70°30'54" | 147°20'48" | 800/244 | 21 | 355 | O | | |

*O - original sighting.
R - possible resighting.

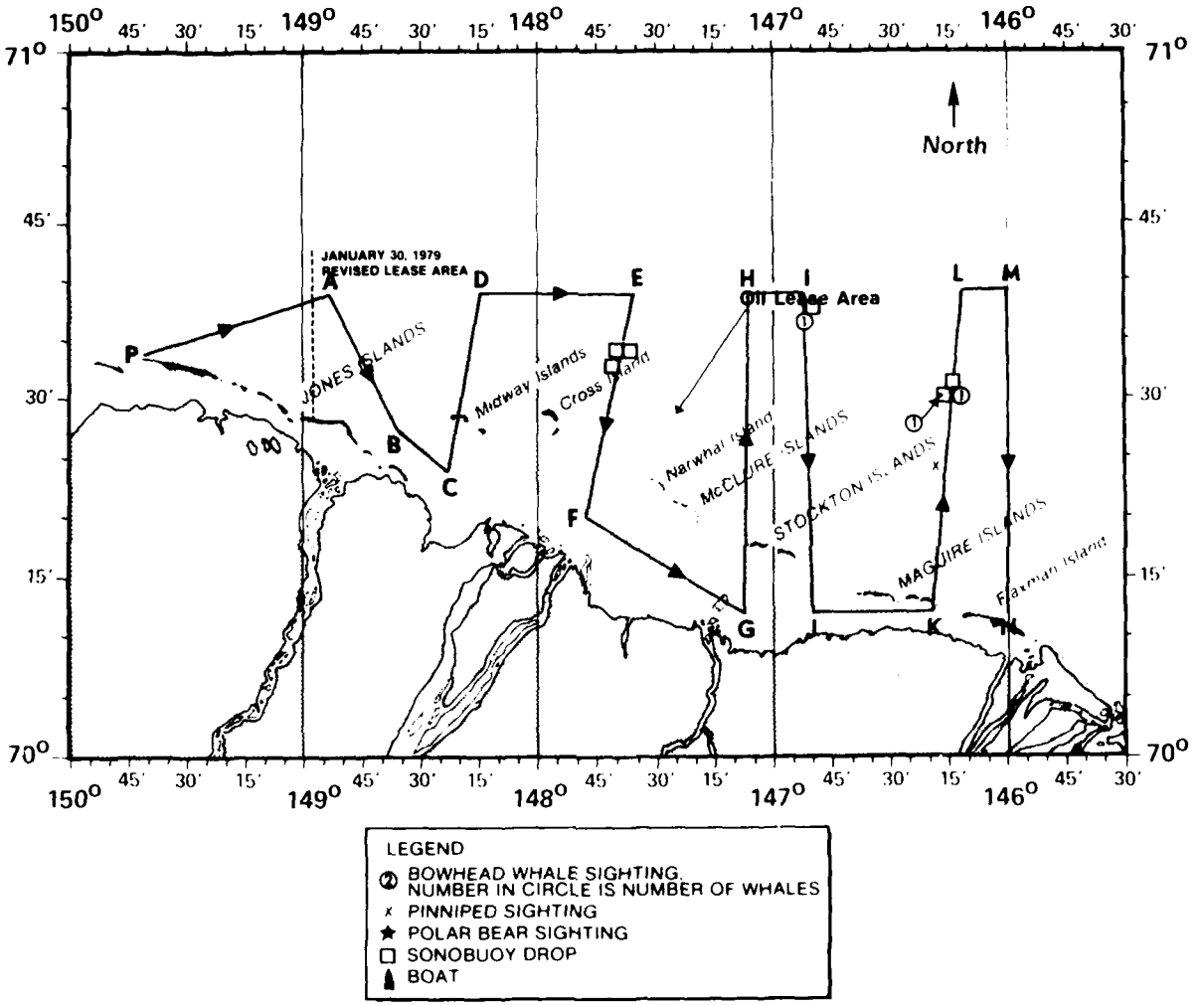



Flight 45, 14 October 1979, Block #1. Thirty-five bowhead whale sightings for a total of 44 individuals including two cow and calf pairs (table B12); five sonobuoy drops were made. Dashed line indicates a refueling break at point J. The transect was resumed at point N and run backwards until point J was reached. Weather conditions varied from snow to overcast. Water conditions included solid shorefast ice, pancake ice, slush ice, grease ice, and open water. Aircraft altitude ranged from 420-1000 ft (128-305 m).

Table B13. Bowhead whale sightings for flight 46, 15 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°37'48" | 146°52'30" | 700/213 | 20 | 13 | O | 0.274/0.508 | |
| 1 | 70°30'54" | 146°14'48" | 600/183 | 10 | 75 | O | 0.524/0.970 | |
| 1 | 70°30'36" | 146°18'36" | 1000/305 | – | 315 | O | | |

*O – original sighting.



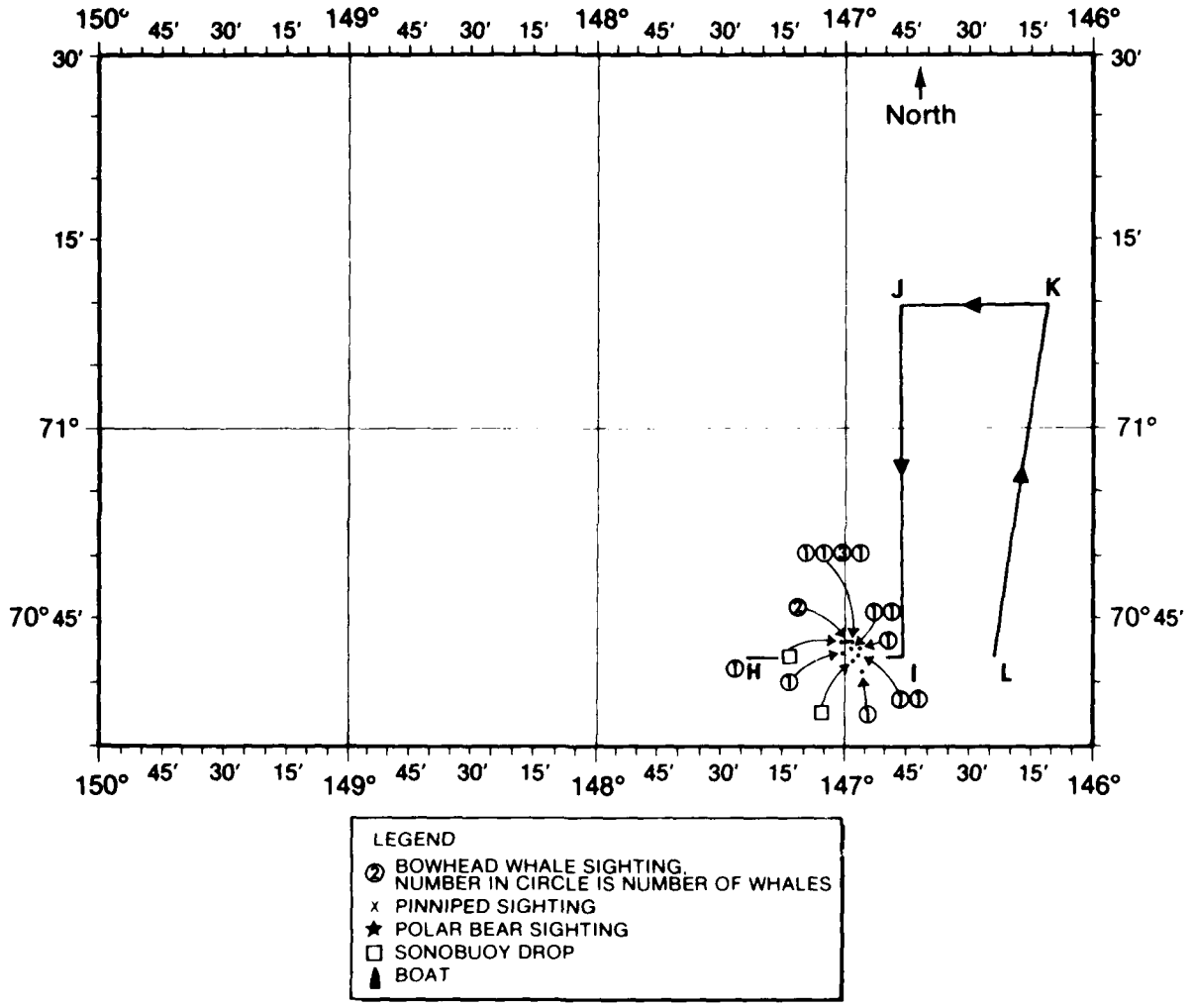

Flight 46, 15 October 1979, Block #1. Three bowhead whale sightings, for a total of three individuals (table B13); six sonobuoy drops were made. Occasional snow flurries were present with overcast skies; visibility ranged from very good to poor. Water conditions included solid ice with holes, pancake ice, slush, grease ice, and open water. Aircraft altitude ranged from 600-1000 ft (183-305 m).

Table B14. Bowhead whale sightings for flight 47, 15 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°42'48" | 146°58'18" | 700/213 | – | 222 | O | | |
| 1 | 70°42'12" | 146°56'00" | 700/213 | 9 | 222 | O | | |
| 1 | 70°40'54" | 146°55'12" | 700/213 | 52 | 335 | O | | |
| 1 | 70°42'12" | 146°55'18" | 800/244 | 12 | 35 | R | | |
| 2 | 70°43'30" | 146°59'30" | – | – | 258<br>168 | O<br>O | | |
| 1 | 70°43'30" | 146°58'24" | 700/213 | 20 | 268 | O | | |
| 1 | 70°42'48" | 146°59'00" | 700/213 | 26 | 265 | R | | |
| 1 | 70°43'06" | 146°58'06" | 700/213 | 12 | 88 | R | | |
| 3 | 70°43'06" | 146°58'06" | 700/213 | 10 | 88 | R | | |
| 1 | 70°42'12" | 147°00'54" | 700/213 | -- | – | O | | Not moving; in open water track in slush ice |
| 1 | 70°43'00" | 146°58'12" | 700/213 | 22 | 38 | R | | |
| 1 | 70°43'00" | 147°01'06" | 700/213 | 50 | 358 | O | | Large adult; in open water track in slush ice |
| 1 | 70°41'18" | 147°26'18" | 700/213 | 10 | · | O | | |

*O – original sighting.

R – possible resighting.

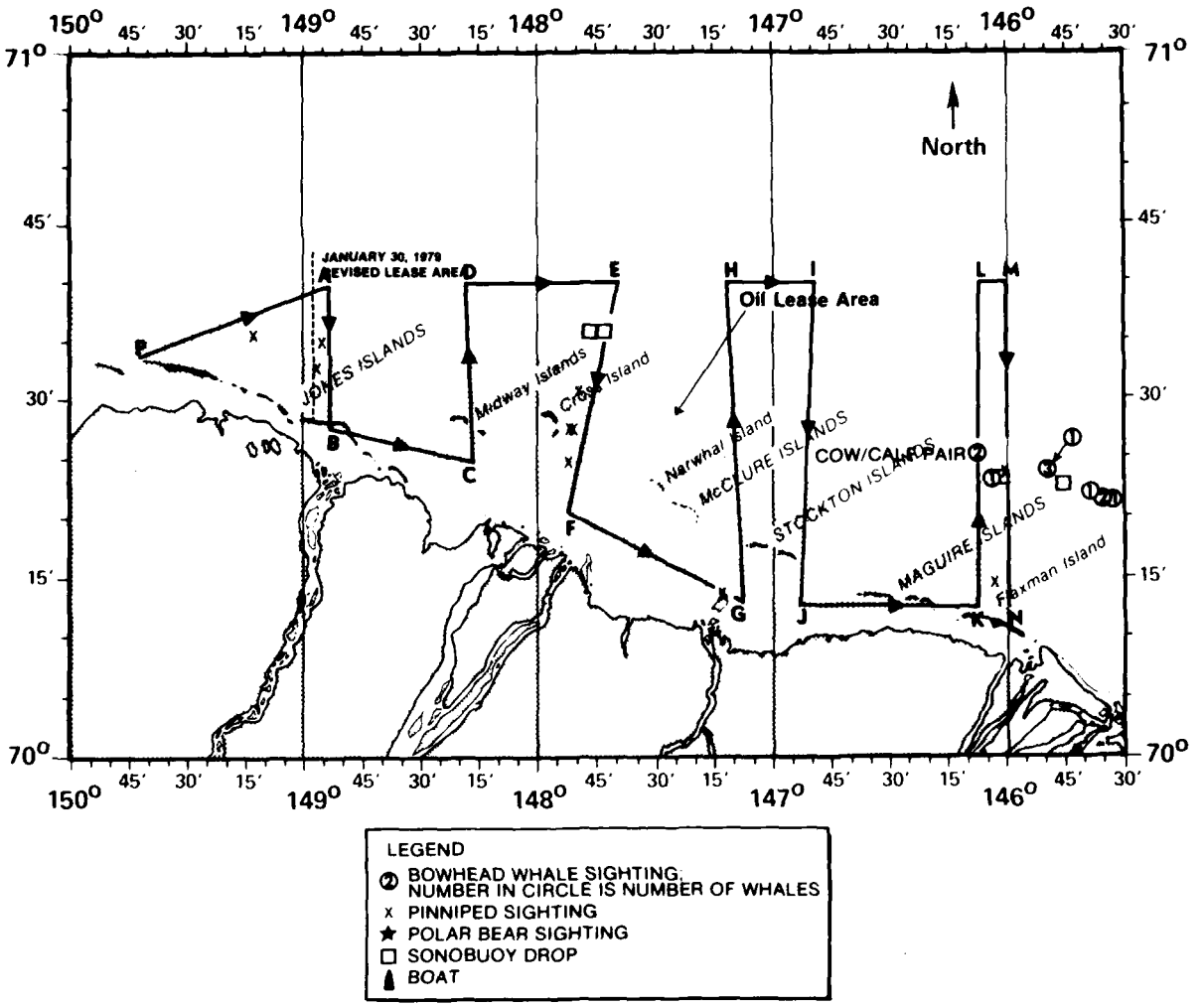



Flight 47, 15 October 1979, Block #2. Thirteen bowhead whale sightings, for a total of 16 individuals (table B14); two sonobuoy drops were made. Transect terminated because of darkness. Visibility ranged from excellent to poor under thick overcast with occasional snowstorms. Slush and grease ice were extensive, with open water only to the north and northeast. Aircraft altitude was 700 ft (213 m).

Table B15. Bowhead whale sightings for flight 48, 16 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°23'06" | 146°04'36" | 1000/305 | 10 | 298 | O | 0.873/1.617 | |
| 2 | 70°25'06" | 146°06'54" | 1000/305 | 25 | 028 | O | | Cow with small calf. |
| 3 | 70°23'00" | 145°49'00" | — | — | — | O | | |
| 1 | 70°23'00" | 145°49'00" | — | — | — | O | | Part of a group of 4 milling about in the same lead; fourth one popped up at a different time. |
| 1 | 70°22'54" | 145°37'18" | 600/183 | 13 | 248 | O | 0.391/0.725 | |
| 2 | 70°21'54" | 145°34'06" | 600/183 | 32 | — | O | | Both large adults. |
| 1 | 70°21'24" | 145°31'12" | 670/204 | 27 | 258 | O | | |

*O - original sighting.

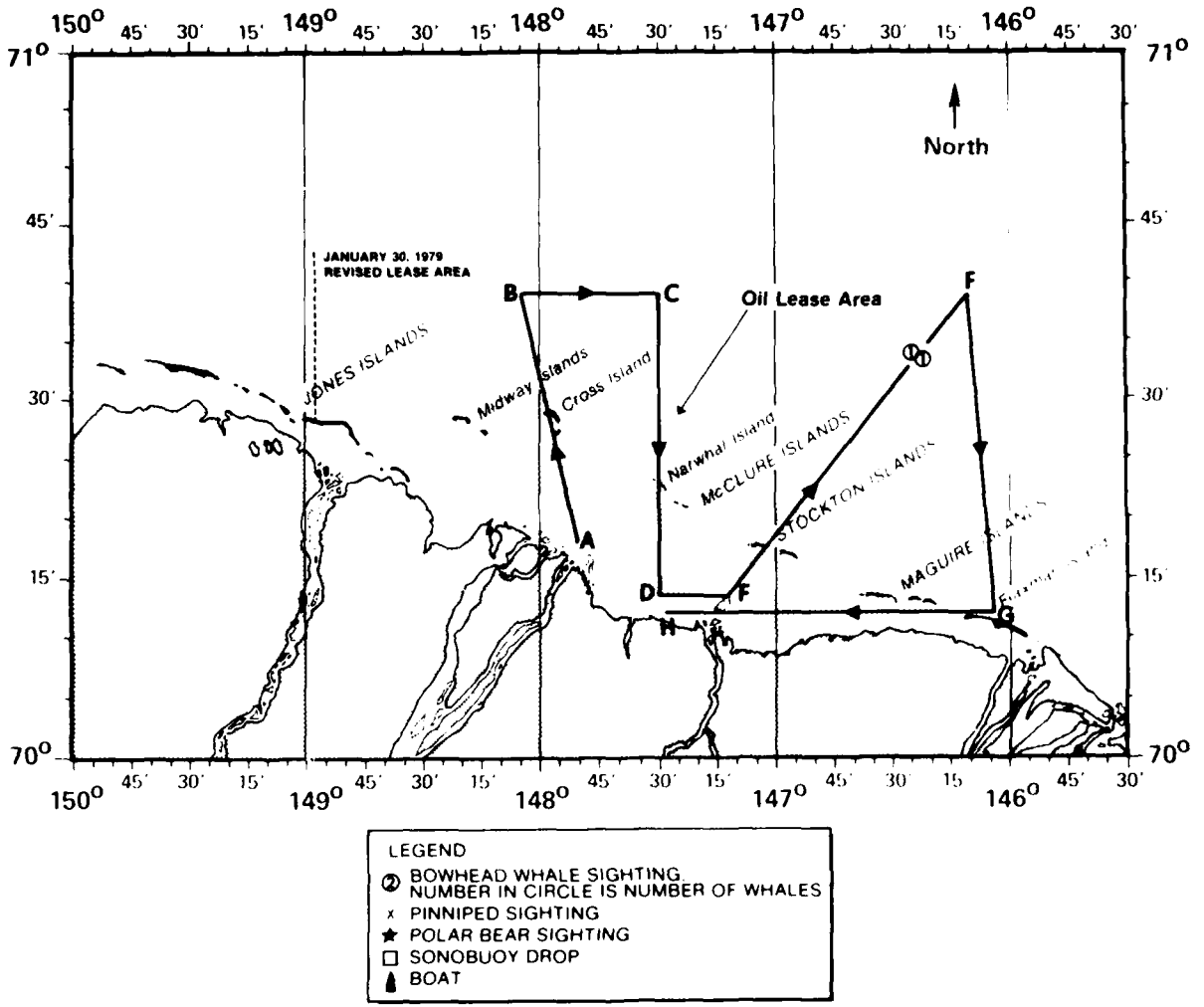



Flight 48, 16 October 1979, Block #1. Seven bowhead whale sightings, for a total of 11 whales, including a cow and calf pair (table B15); nine pinniped sightings, totalling 10 individuals; four sonobuoy drops were made. Visibility ranged from excellent to poor because of snow storms. The solid ice near shore was starting to raft; pancake, slush, and grease ice covered most of the area. Aircraft altitude ranged from 800-1000 ft (244-305 m).

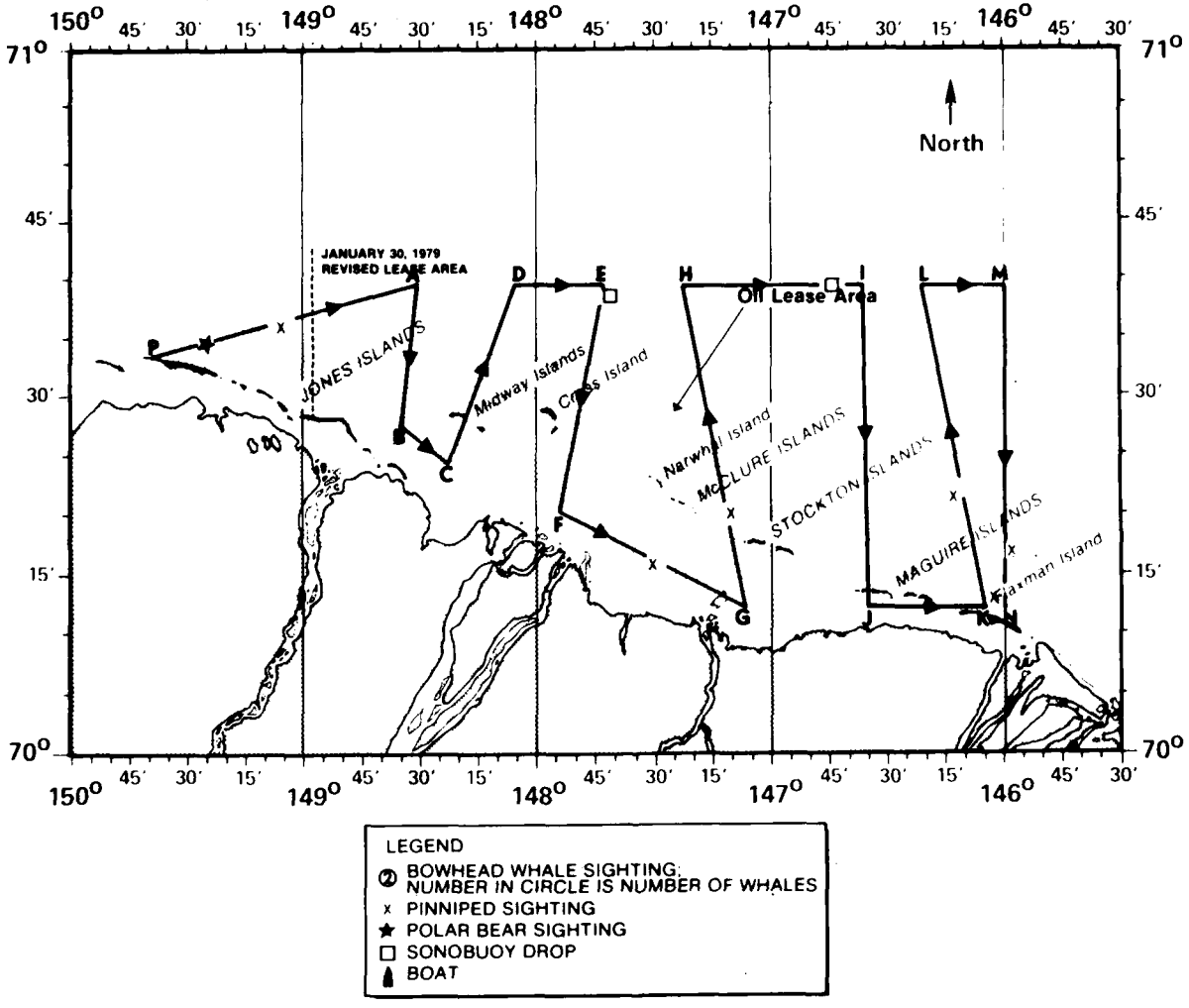
Table B16. Bowhead whale sightings for flight 49, 17 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°33'36" | 146°23'12" | 800/244 | 10 | 303 | O | 0.699/1.294 | About 40 ft long; seen in open water lead; blew 3 times at surface. |
| 1 | 70°34'00" | 146°25'48" | 800/244 | 90 | 38 | O | 0 0 | Lying still in water; in open water lead. |

*O – original sighting.




Flight 49, 17 October 1979, Block #1. Two bowhead whale sightings, for a total of two whales (table B16), were made. Visibility ranged from good to fair with strong winds and blowing snow. Open water with grease ice existed only to the north and northeast; the rest of the water was covered with either solid ice with leads or large pancakes. Aircraft altitude was 800 ft (244 m).

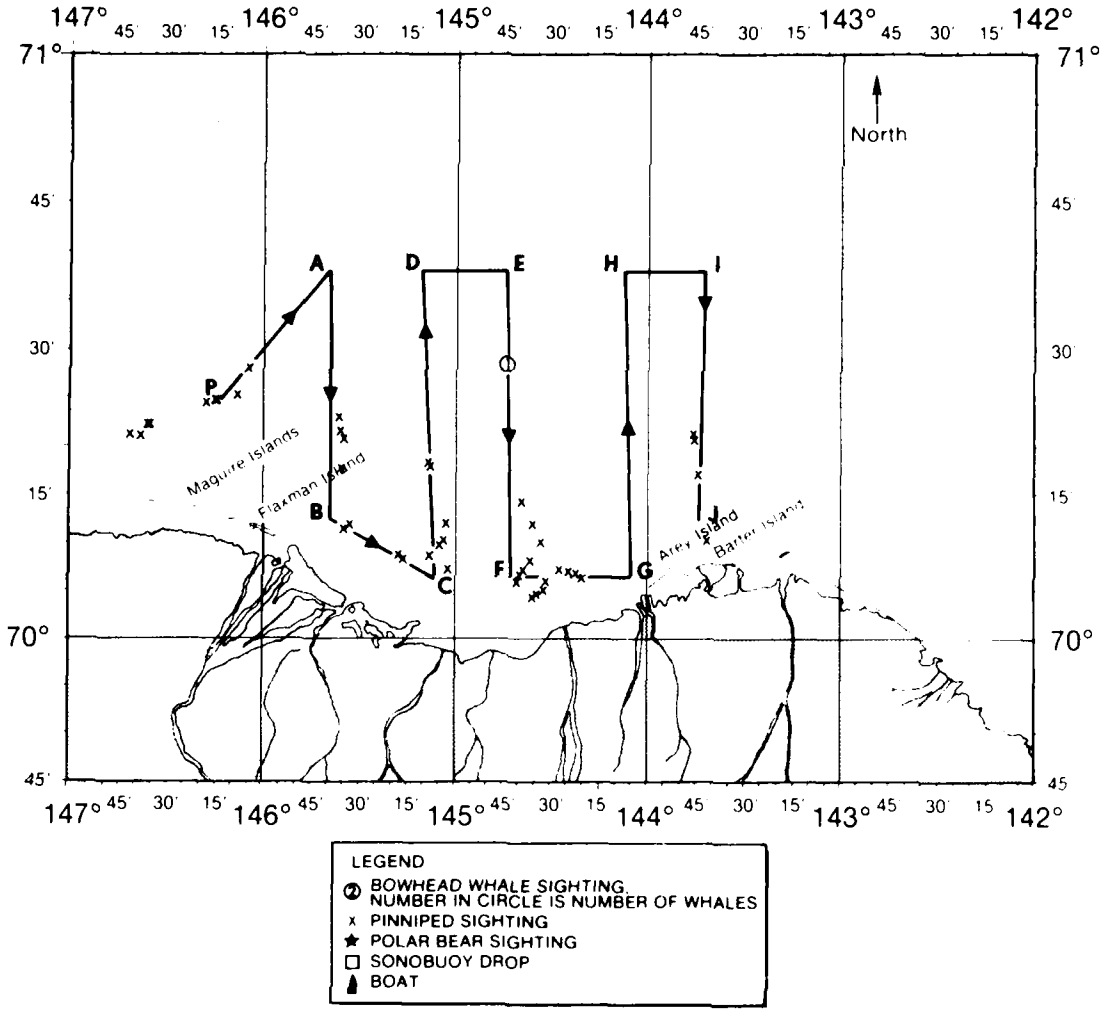



Flight 50, 18 October 1979, Block #1. Six pinniped sightings, for a total of seven individuals; one polar bear sighting of one individual; two sonobuoy drops were made. Visibility was good under low overcast; the water was totally covered with ice, either solid with holes and leads, broken pancake ice, or slush ice. Aircraft altitude was 700 ft (213 m).

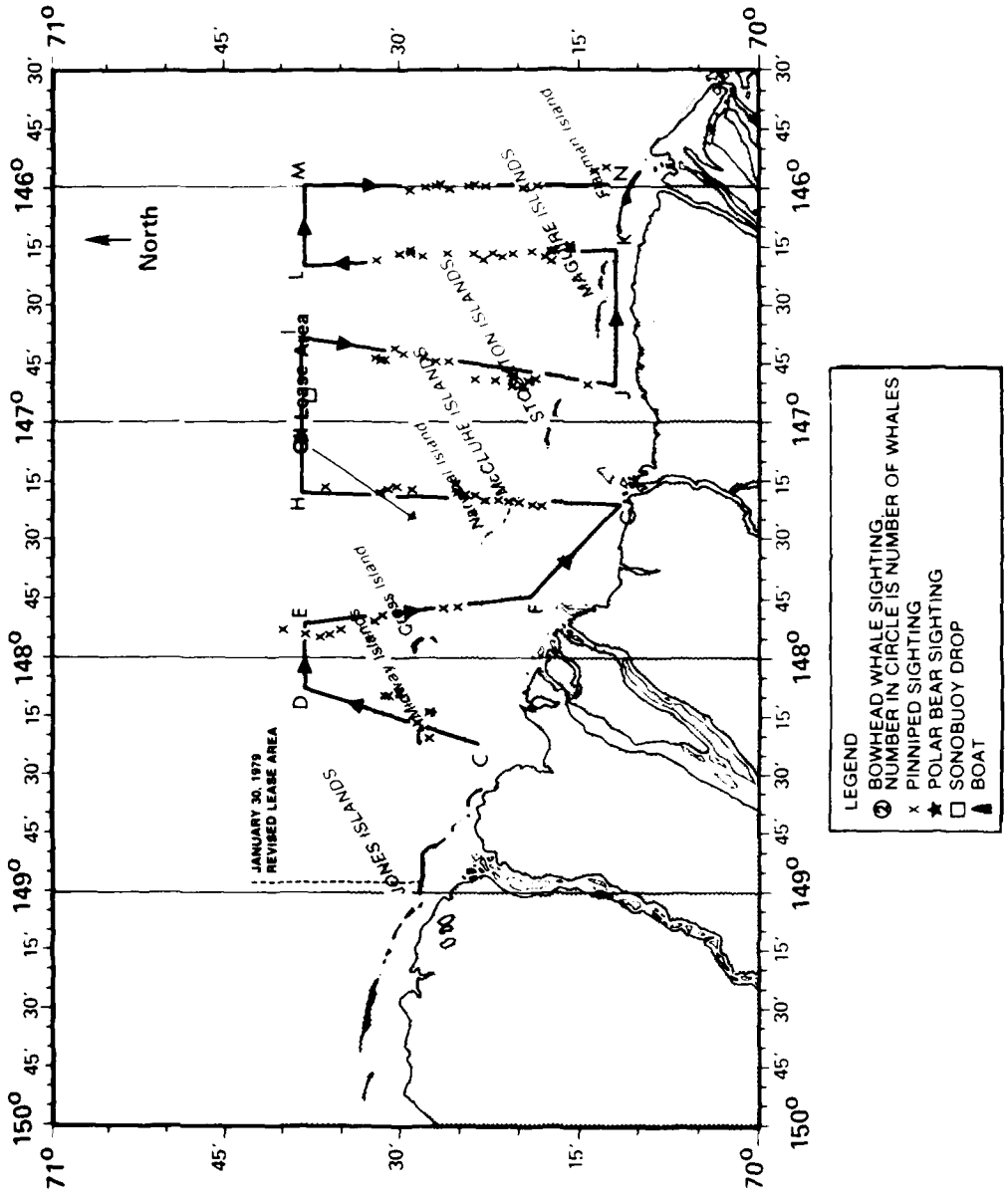
Table B17. Bowhead whale sightings for flight 51, 18 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°28'18" | 144°45'30" | 800/244 | 21 | 248 | O | | Dove immediately; was seen in more open water surrounded by 6 to 7 octates of slush ice. |

*O – original sighting.




Flight 51, 18 October 1979, Block #3. One bowhead whale sighting of one individual (table B17) and forty-three pinniped sightings for a total of 210 individuals, were made. Visibility ranged from very good to poor under low overcast. The water was covered with slush and grease ice. Aircraft altitude ranged from 700-1000 ft (213-305 m). The transect was terminated at point J because of darkness.

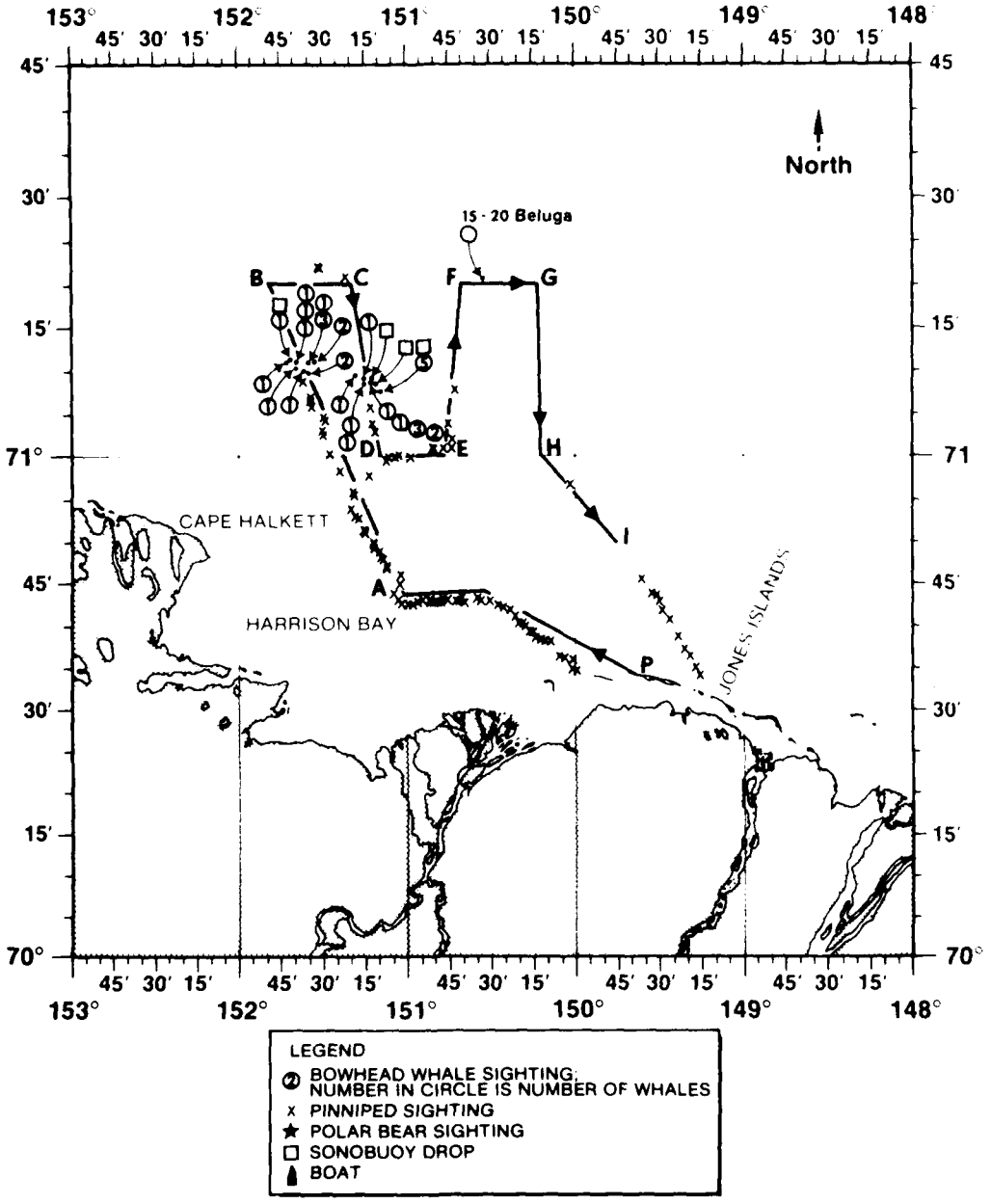



Flight 52, 19 October 1979, Block #1. Eighty-eight pinniped sightings for a total of 285 individuals; one sonobuoy drop was made. Visibility ranged from excellent to fair, with overcast skies and snow flurries. The water was covered by solid ice with holes and leads or, to the north and east, pancake and slush ice. Aircraft altitude ranged from 500-800 ft (152-244 m).

Table B18. Bowhead whale and beluga sightings for flight 53, 19 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 71°10'54" | 151°39'00" | 400/122 | 10 | 0 | O | | About 25 ft long. |
| 1 | 71°10'42" | 151°38'30" | 400/122 | 8 | 318 | O | | |
| 1 | 71°10'54" | 151°39'12" | – | - | | R | | |
| 1 | 71°11'12" | 151°40'24" | – | – | - | O | | About 35 ft long. |
| 1 | 71°11'00" | 151°41'12" | 500/152 | 13 | | O | | |
| 1 | 71°10'18" | 151°38'48" | 500/152 | 13 | | O | | |
| 1 | 71°10'06" | 151°36'24" | 500/152 | 10 | 203 | O | | |
| 2 | 71°10'00" | 151°35'18" | 500/152 | 14 | 255 | O | | Both are 40 to 50 ft long. |
| 2 | 71°10'48" | 151°33'36" | 500/152 | 18 | 155 | | | |
| | | | | | 205 | O | | |
| 1 | 71°10'36" | 151°35'18" | – | – | – | O | | One about 45 ft long, slapping water with flukes. |
| 3 | 71°10'36" | 151°35'18" | – | – | – | O | | In a group on other side of plane. |
| 1 | 71°08'30" | 151°15'48" | 300/91 | 2 | 328 | O | | |
| 2 | 71°09'00" | 151°12'00" | 800/244 | 17 | 38 | O | | |
| 3 | 71°08'48" | 151°12'48" | – | – | 243 | O | | |
| | | | | | 333 | | | |
| | | | | | 288 | | | |
| 1 | 71°09'30" | 151°18'00" | 580/177 | 47 | 268 | O | | |
| 5 | 71°07'48" | 151°09'00" | – | – | – | O | | All 5 in same lead, one breached in front of plane. |
| 1 | 71°08'54" | 151°13'36" | 600/183 | 31 | 248 | O | | |
| 1 | 71°08'36" | 151°15'36" | 600/183 | 22 | 197 | R | | |
| 1 | 71°09'00" | 151°15'42" | 600/183 | 12 | 171 | R | | |
| 1 | 71°08'24" | 151°12'30" | 600/183 | – | 149 | R | | |
| 15-20 | 71°21'06" | 150°32'36" | 500/152 | 15 | 63 | O | | Very fat belugas, determinedly travelling in straight lines. |

*O – original sighting.
R – possible resighting.

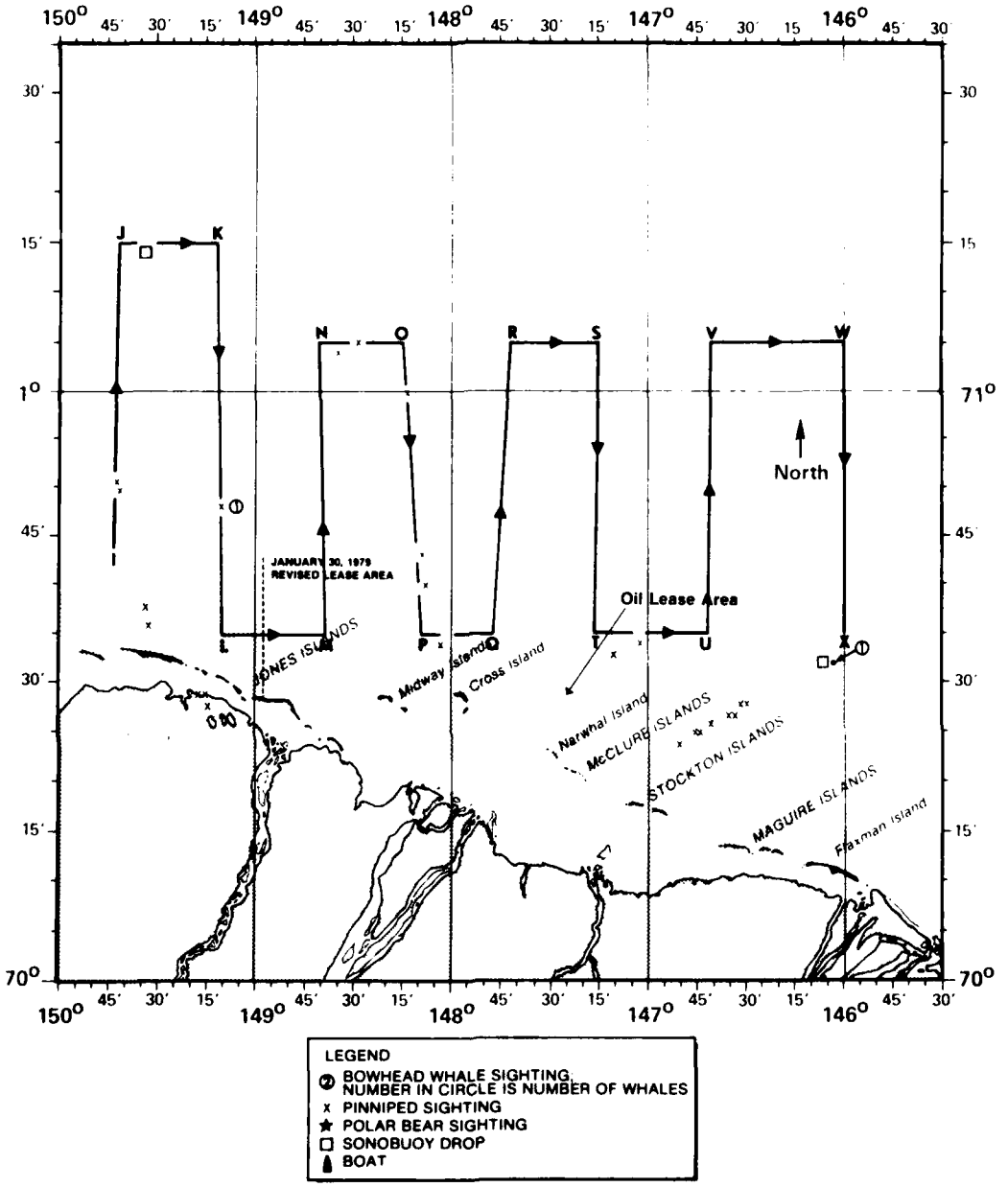



Flight 53, 19 October 1979, northwest of Block #1. Nineteen bowhead whale sightings for a total of 32 individuals (table B18); 128 pinniped sightings, for a total of 320 individuals; one sighting of 15 to 20-plus beluga; five sonobuoy drops were made. Visibility was good under overcast skies. Thin but solid ice with holes and leads existed over most of the area. Aircraft altitude ranged from 300-1000 ft (91-305 m).

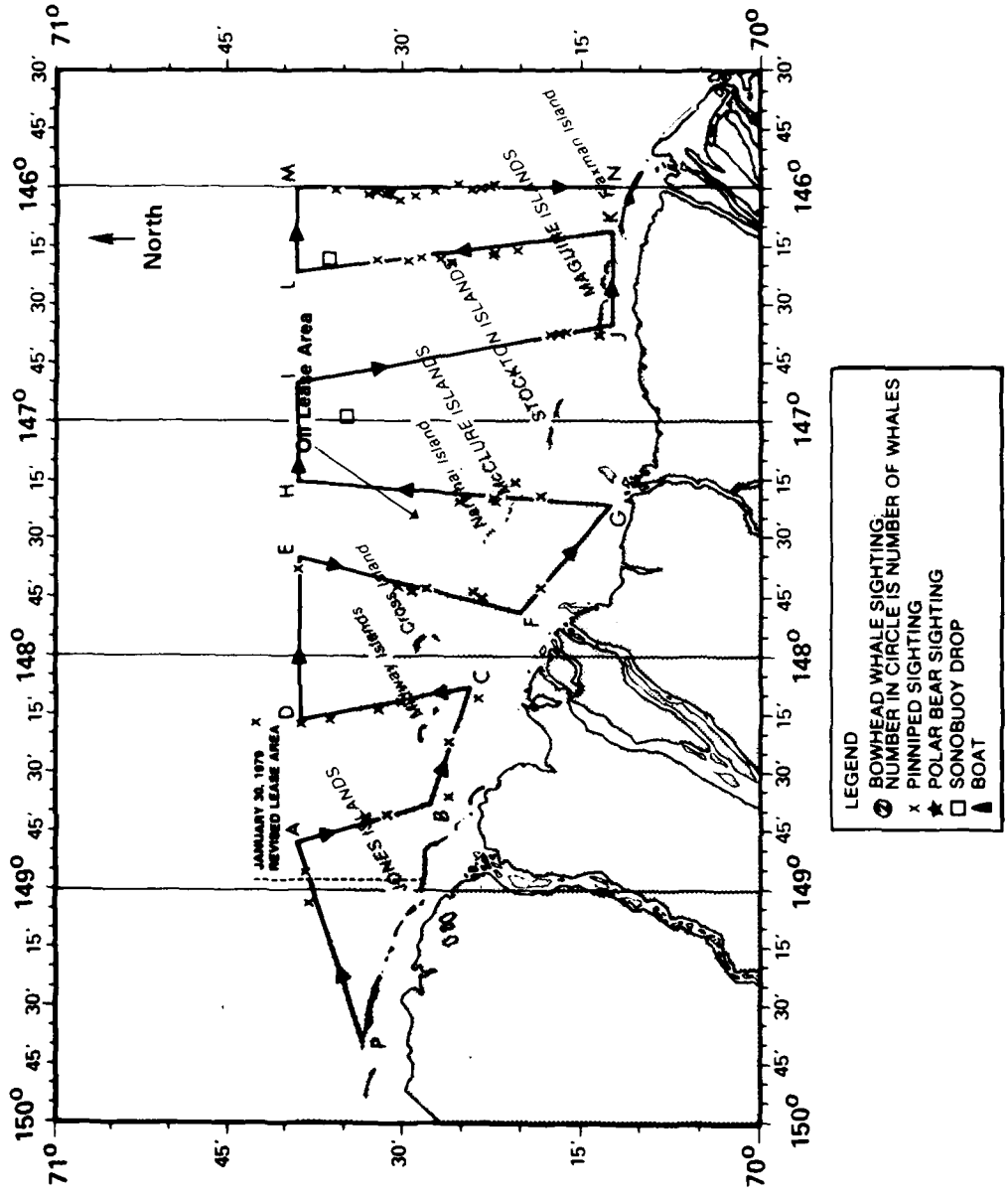
Table B19. Bowhead whale sightings for flight 54, 20 October 1979. Perpendicular distances are included only for those sightings used to calculate the density estimate.

| No of Whales | Latitude, N | Longitude, W | Altitude, ft /m | Clinometer Angle, deg | Heading, deg | Sighting Status* | Perpendicular Distance, mi /km | Behavior/Comments |
|---|---|---|---|---|---|---|---|---|
| 1 | 70°58'24" | 148°40'18" | 500/152 | 14 | | O | | About 40 ft long; seen in open water lead. |
| 1 | 70°37'54" | 146°04'06" | 500/152 | 21 | 008 | O | | About 35 to 40 ft long. |

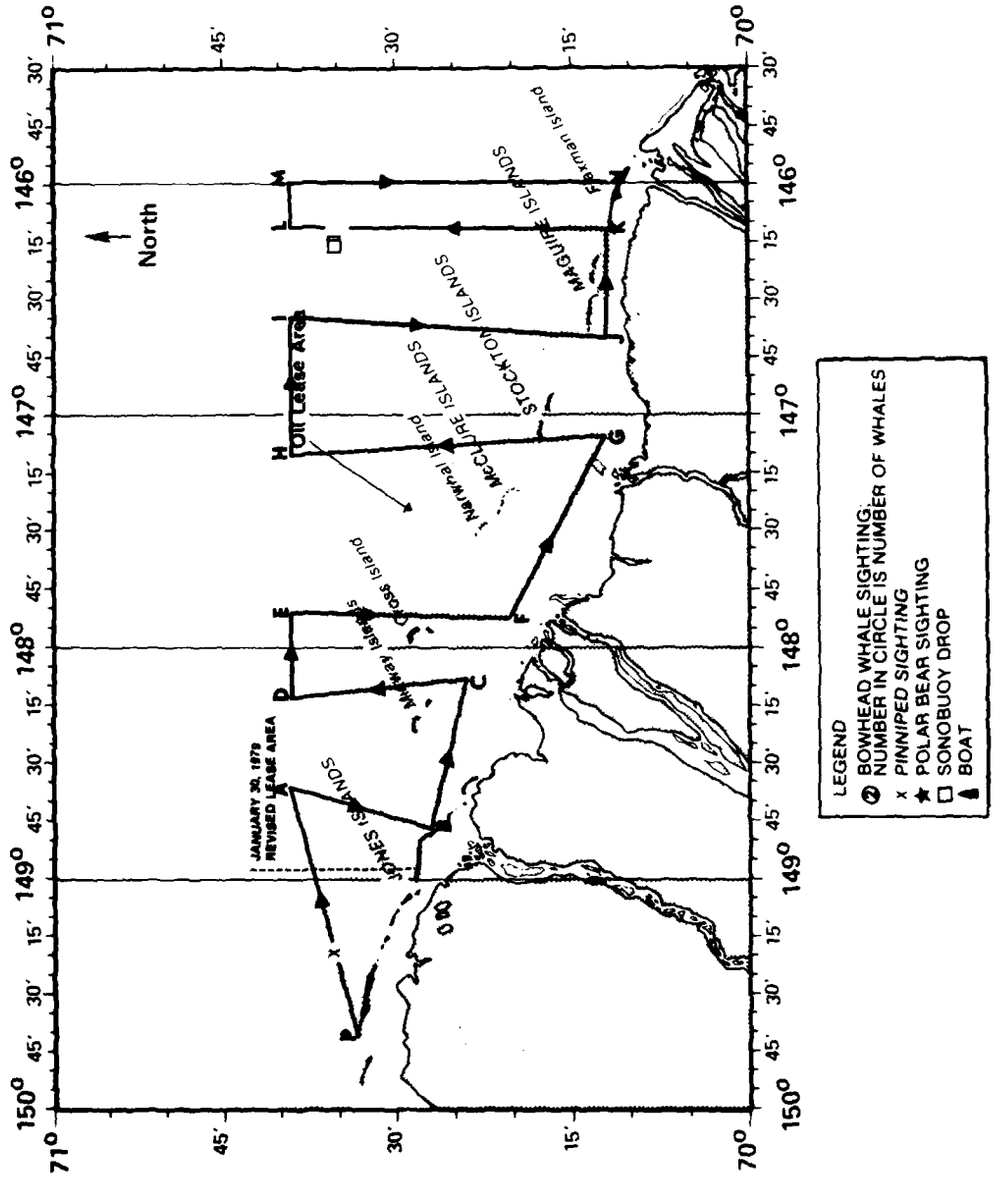
*O – original sighting.



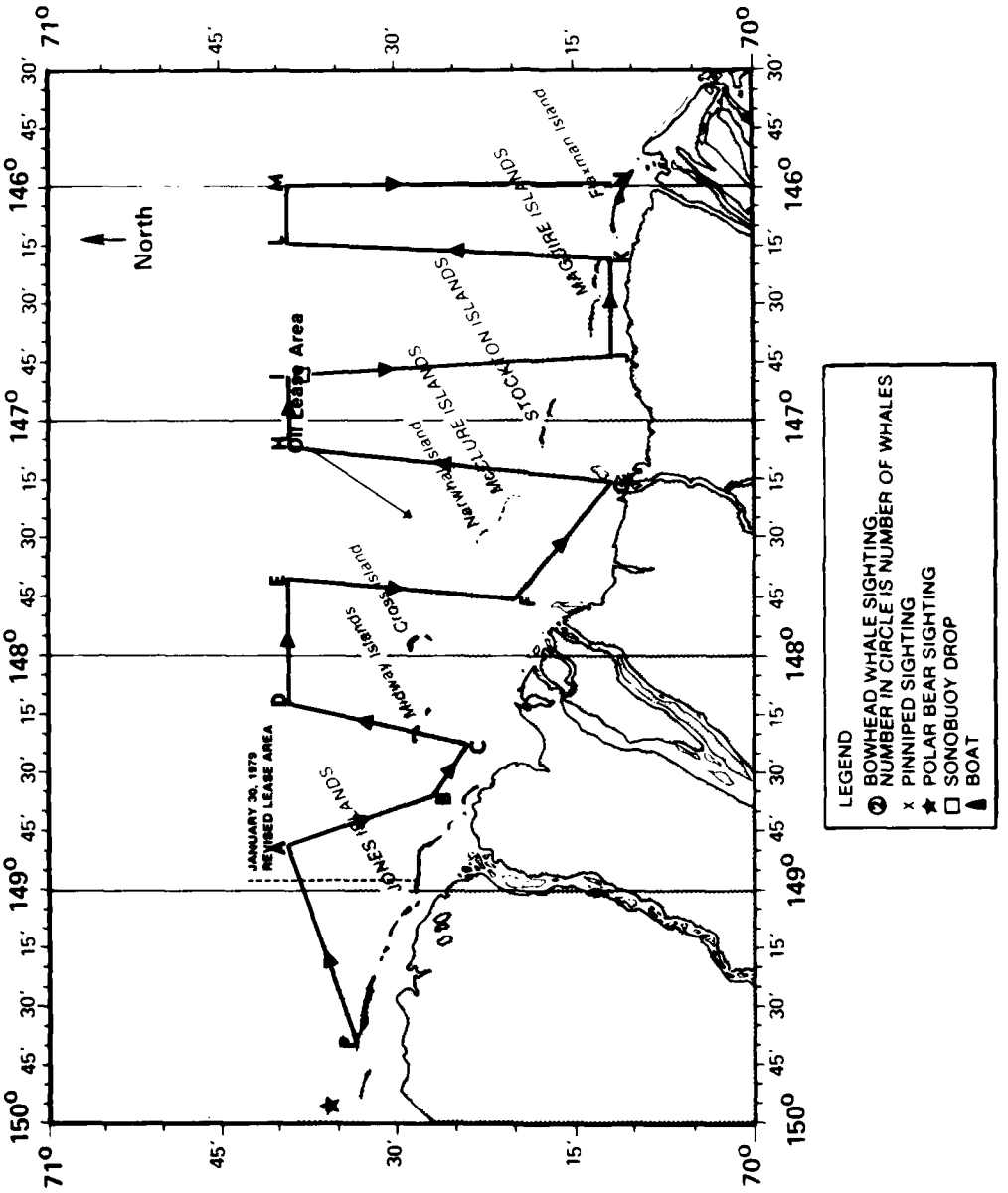

Flight 54, 20 October 1979, Block #2. Two bowhead whale sightings for a total of two whales (table B19); 24 pinniped sightings, totalling 48 individuals; two sonobuoy drops were made. Visibility ranged from very good to poor, with fog patches and snow flurries. Area covered almost totally by thin but solid ice with holes and leads. Aircraft altitude ranged from 350-1000 ft (107-305 m).



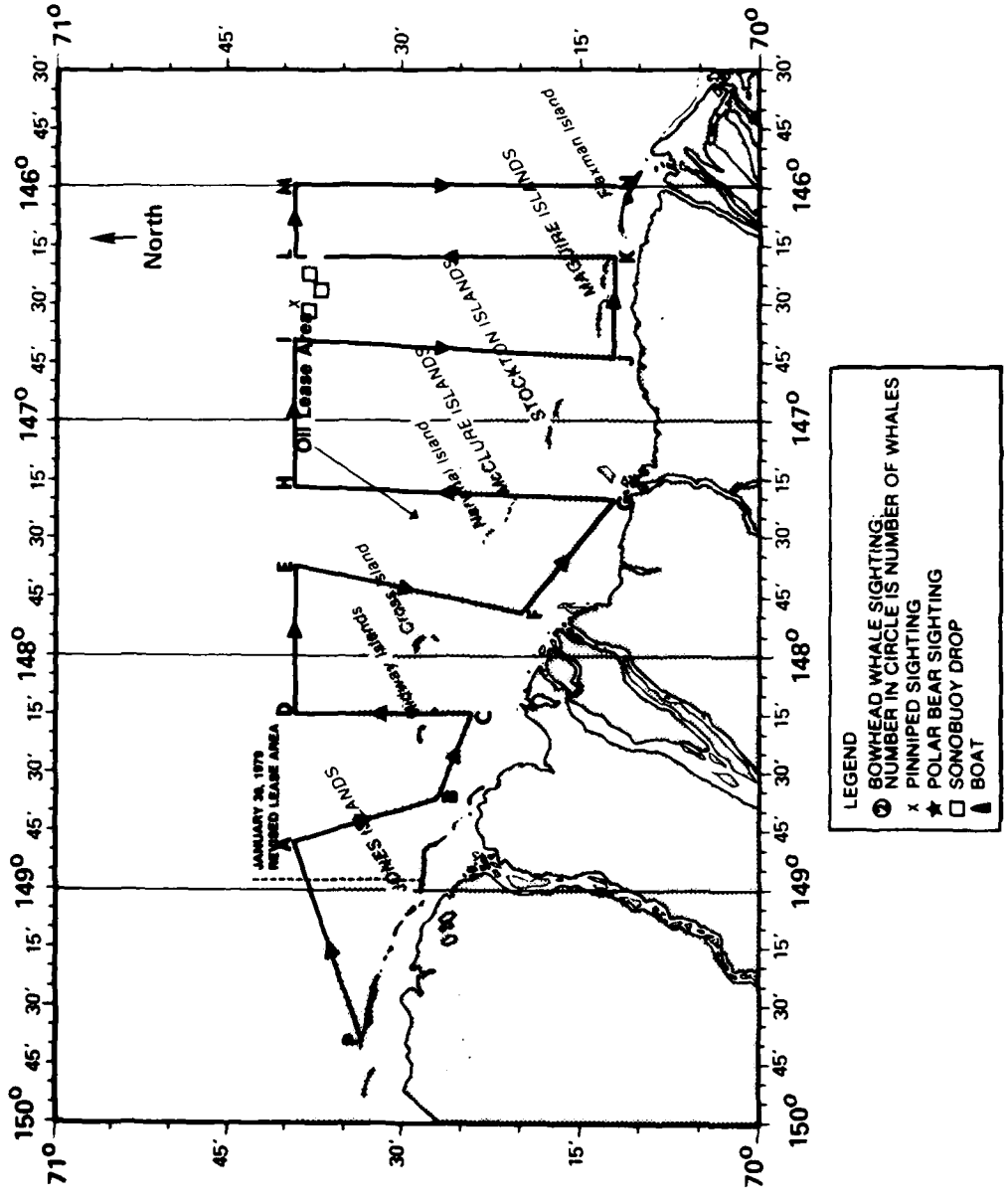

*Flight 55, 21 October 1979, Block #1. Fifty-five pinniped sightings for a total of 89 individuals; one polar bear sighting of one individual; two sonobuoy drops were made. Visibility ranged from excellent to poor because of fog patches. Much of the solid ice in the northern half had been broken into pancake ice. Aircraft altitude ranged from 300-500 ft (91-152 m).*



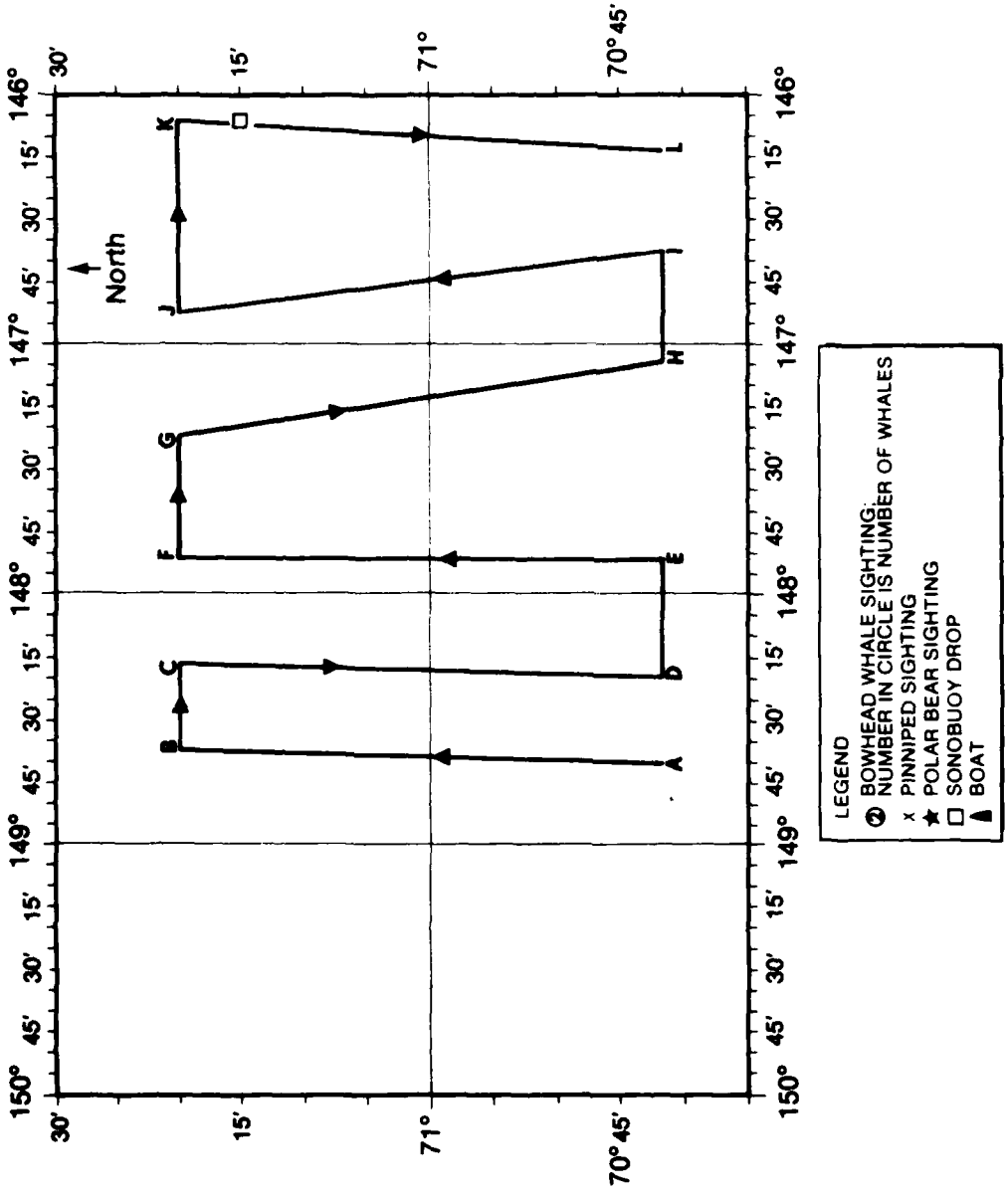

Flight 56, 23 October 1979, Block #1. One pinniped sighting, two sonobuoy drops were made. A very strong easterly wind helped provide excellent visibility, and had pushed the ice westward, opening the water in the northeast quadrant. Aircraft altitude was 800 ft (244 m).



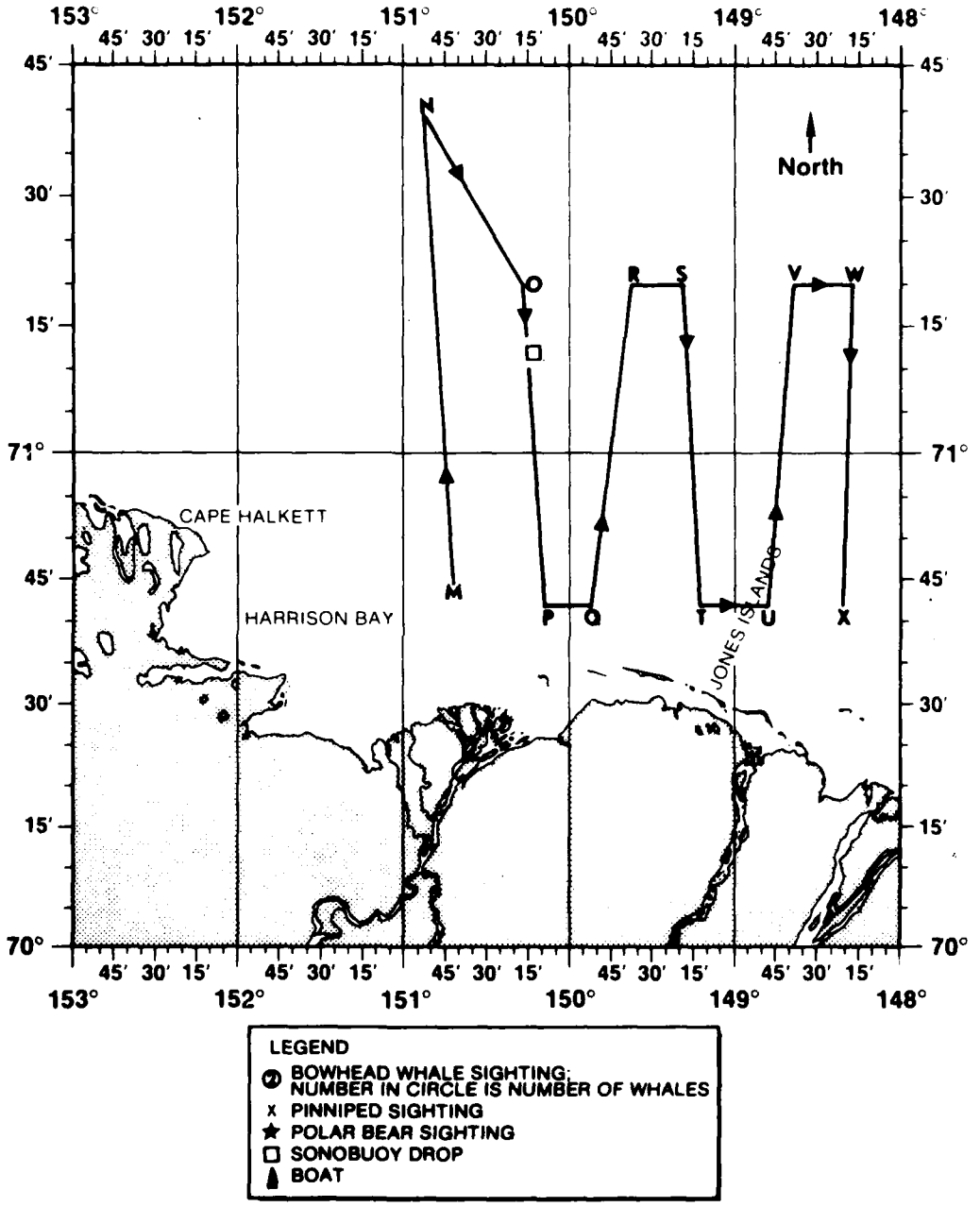

Flight 57, 25 October 1979, Block #1. One polar bear sighting of one individual; one sonobuoy drop was made. A strong wind and blowing snow flurries caused visibility to range from good to poor. There was open water with slush ice in the northeast quadrant. Aircraft altitude ranged from 400-500 ft (122-152 m).



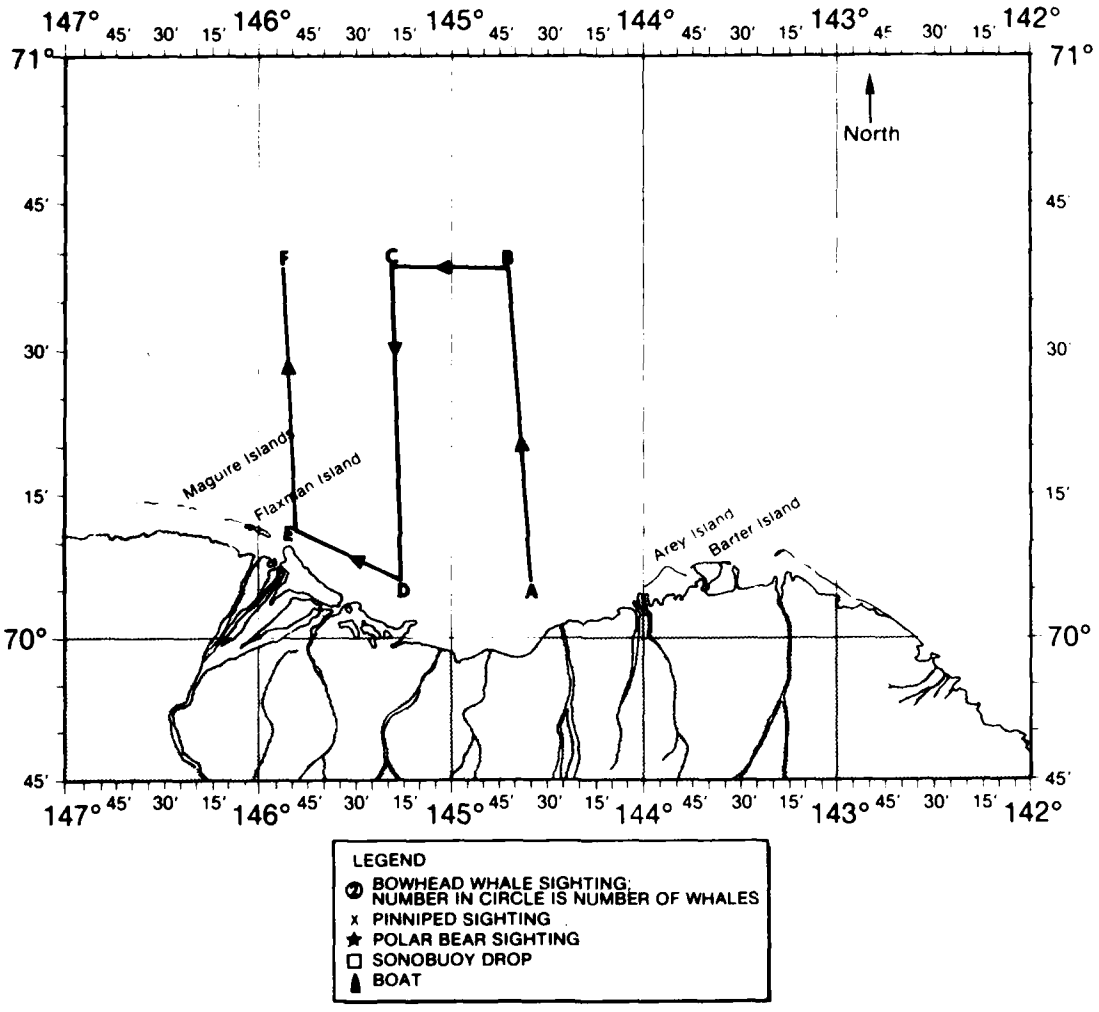

Flight 58, 26 October 1979, Block #1. One pinniped sighting; three sonobuoy drops were made. Visibility ranged from excellent to good under overcast skies, with some snow falling. The water was covered with solid ice, with small holes near shore and big leads offshore. Aircraft altitude was 500 ft (152 m).



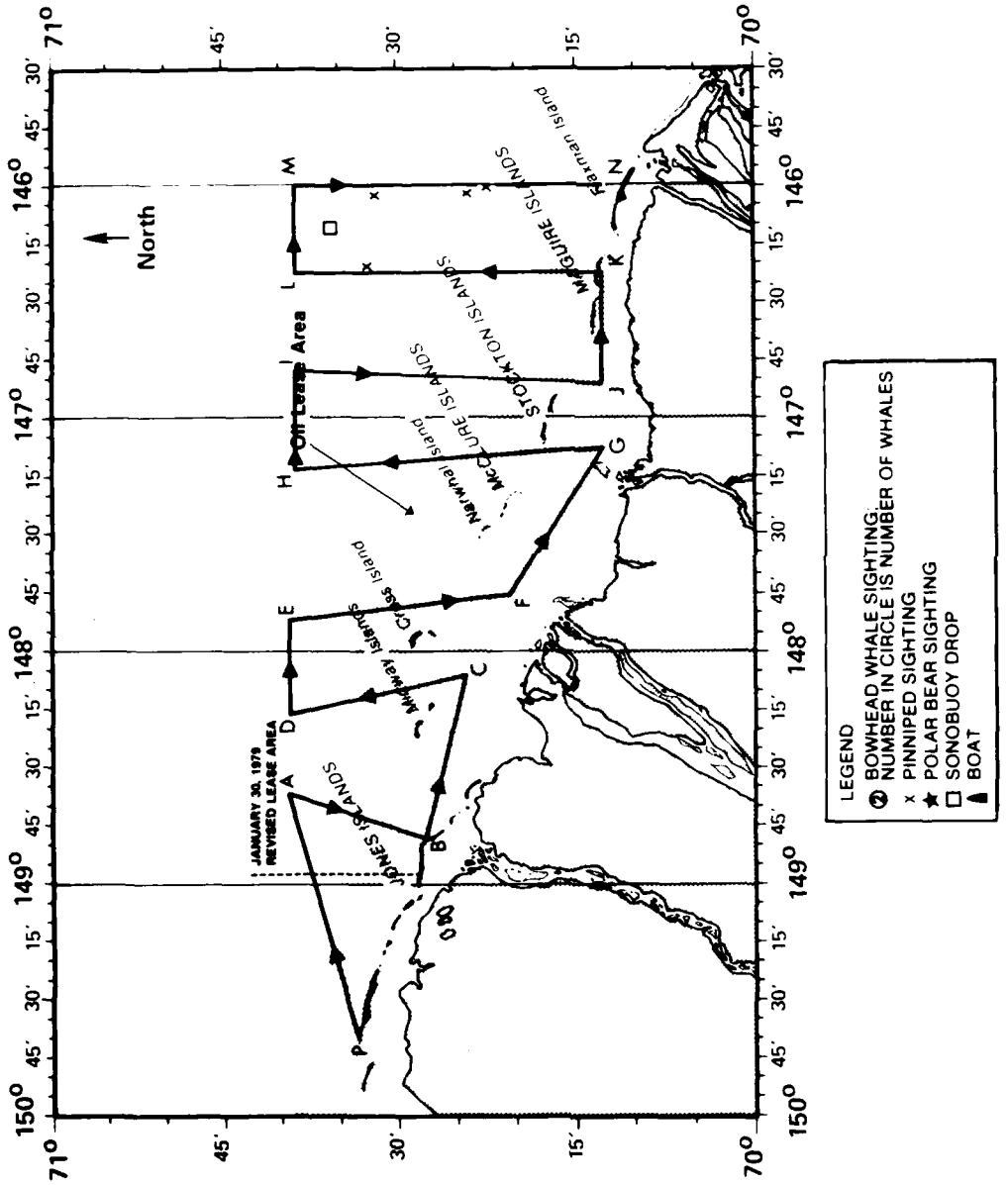

Flight 59, October 1979, Block #2. No sightings were made; one sonobuoy was dropped. Excellent visibility existed under high clouds. Solid ice with holes and leads was present everywhere. Aircraft altitude was 1000 ft (305 m).



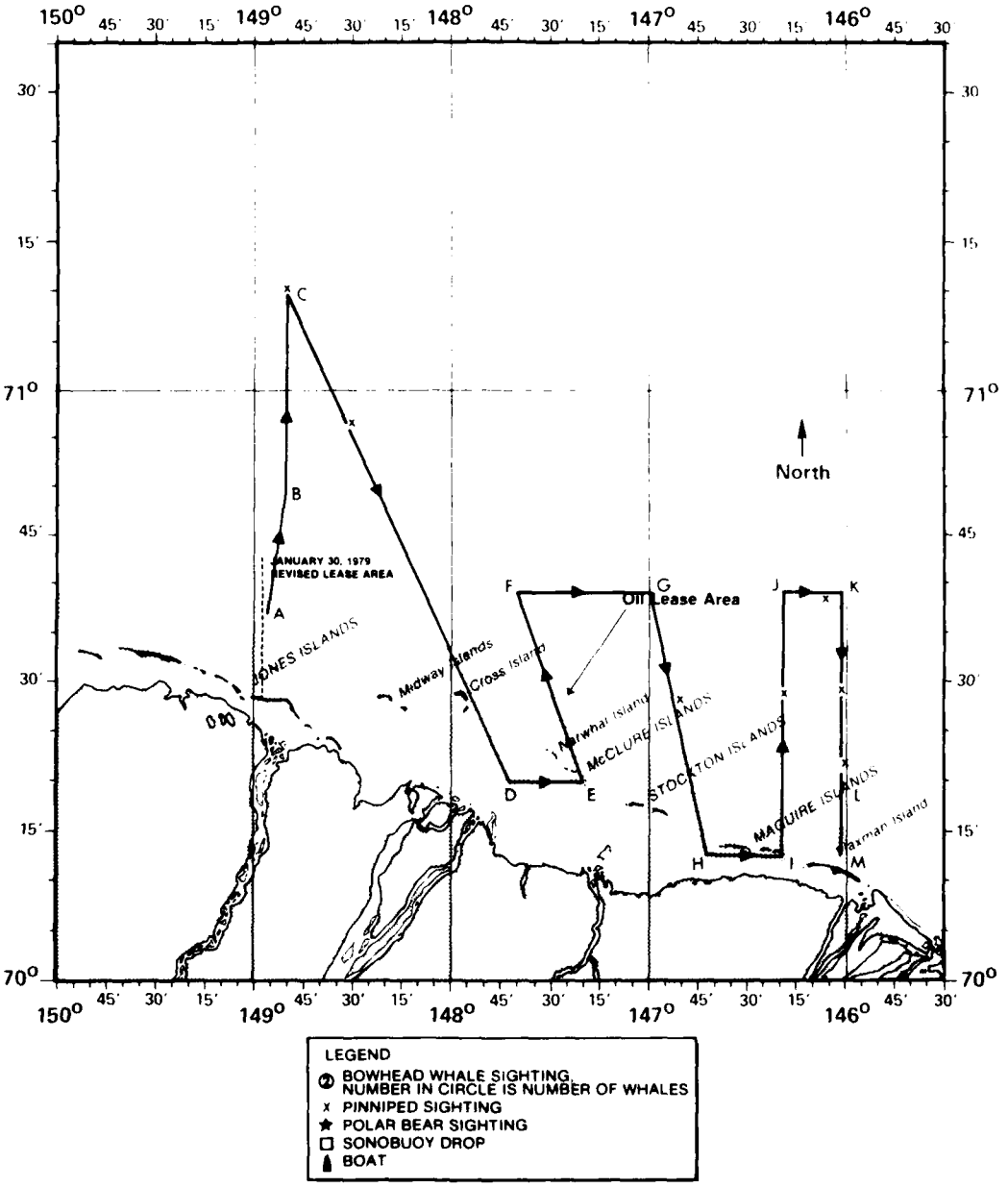

Flight 60, 27 October 1979, northwest of Block #1. No sightings were made; one sonobuoy was dropped. Visibility ranged from excellent to fair because of fog patches. The ice was solid, with holes and large, slushy leads. Aircraft altitude ranged from 800-1000 ft (244-305 m).



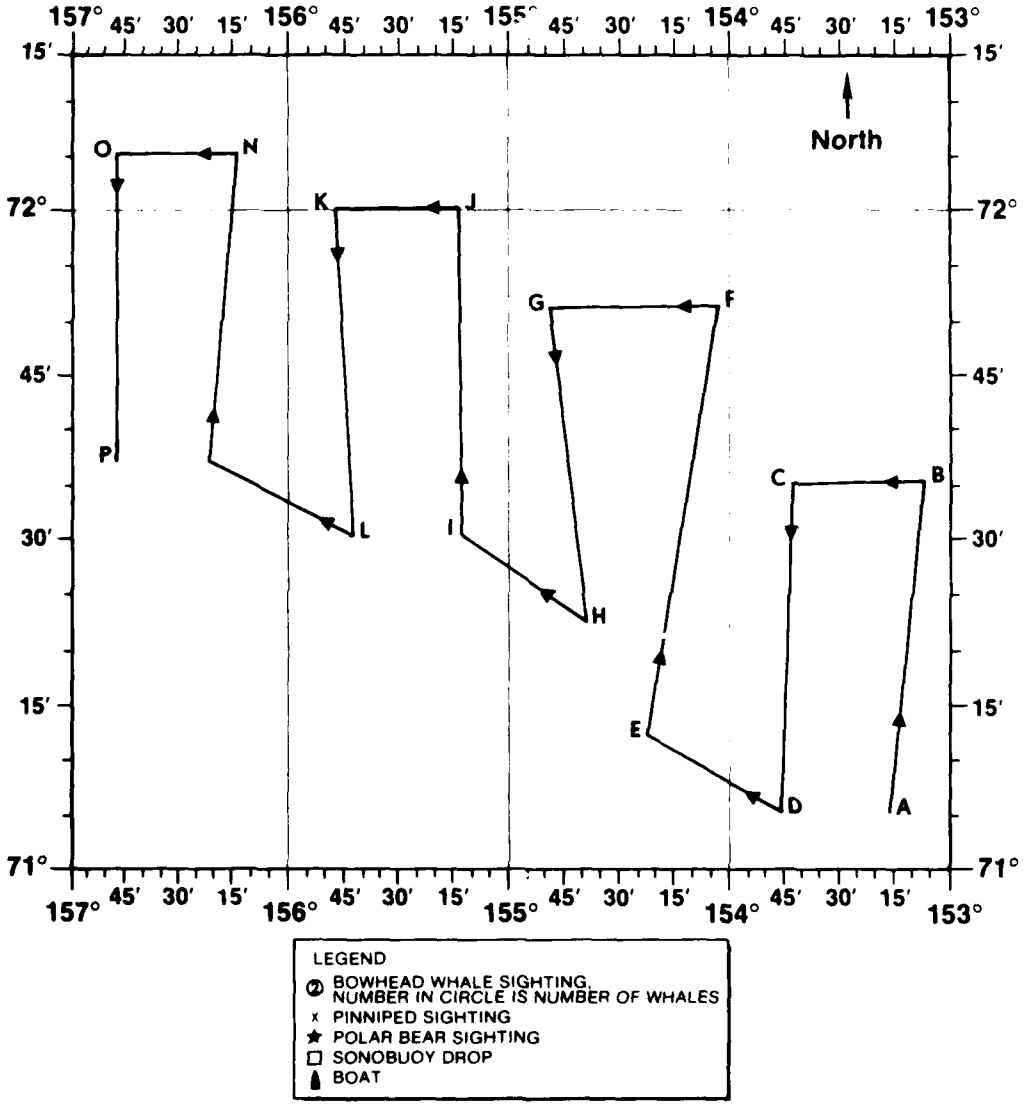

Flight 61, 27 October 1979, Block #3. No sightings were made; transect was terminated because of darkness. Visibility ranged from fair to poor because of fog patches and failing light conditions. The ice was solid, with holes and leads. Aircraft altitude ranged from 500-700 ft (152-213 m).



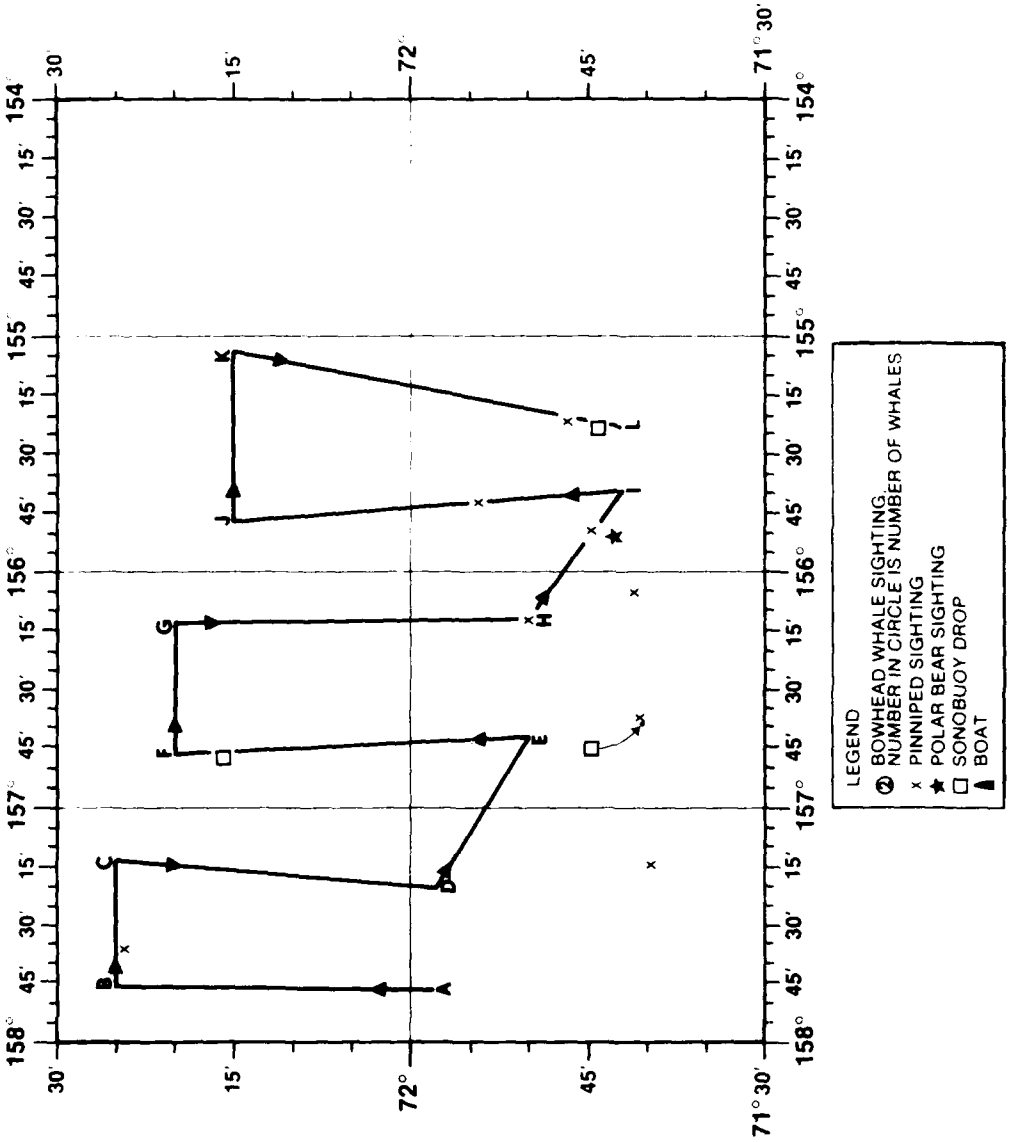

Flight 62, 28 October 1979, Block #1. Four pinniped sightings, for a total of four individuals; one sonobuoy drop was made. Visibility ranged from very good to poor because of fog patches. The ice was solid, with the holes and leads narrowing. Aircraft altitude was 500 ft (152 m).




Flight 63, 29 October 1979, Blocks #1 and 2. Seven pinniped sightings were made. Visibility began as excellent, with bright sunshine, and faded to good and fair because of fog formation. The ice was solid, with small pressure ridges forming. The holes and leads continued to narrow. Aircraft altitude ranged from 500-700 ft (152-213 m).




Flight 64, 30 October 1979, Point Barrow vicinity. No sightings were made. Visibility ranged from good to fair, with gusting winds and blowing snow. The ice was very solid, with some offshore leads open. Aircraft altitude ranged from 300-600 ft (91-183 m).




Flight 65, 31 October 1979, Point Barrow vicinity. Eight pinniped sightings, for a total of nine individuals; one polar bear sighting of one individual; three sonobuoy drops were made. The polar bear sighting and three of the pinniped sightings were made on the return leg. Visibility ranged from fair to poor because of continuous snowfall. The ice was very solid, with offshore leads opening. Aircraft altitude ranged from 50-700 ft (15-213 m).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CONT

# SUPPLEMENTARY

# INFORMATION

AD-A086154

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152
12 March 1981

NOSC Technical Document 314
AERIAL SURVEYS OF BOWHEAD WHALES, NORTH SLOPE, ALASKA, February 1980,
by DK Ljungblad, MF Platter-Rieger, and FS Shipp, Jr.

## LITERATURE CHANGE

The report, Aerial Surveys of Bowhead Whales, North Slope, Alaska, NOSC Technical Document 314, has been found in error with respect to density estimation. The errors primarily concern pages 23 to 35. Disregard all inferences of bowhead whale density estimates, generated from these pages, in the abstract, text, and summary.

These errors were noticed after the sighting data were re-evaluated.

Methodology for the revised density estimate was taken from Burnham et al (1980). A complete description of the survey technique is provided in the original report, NOSC Technical Document 314 (Ljungblad et al 1980).

The correct density estimate is as follows: 17 whales may be present in the study area which includes the Joint-State-Federal lease area, at any time during the 10 day period of 8 October to 17 October. This period represents peak migration during the fall of 1979.

The 95% confidence interval for the density estimate is 14 to 21 whales.

Note: Extensive revision to correct errors in text was accomplished by DK Ljungblad and Clark S. Winchell of CSC.

AD-A086 154 NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA F/G 8/1
AERIAL SURVEYS OF BOWHEAD WHALES, NORTH SLOPE, ALASKA.(U)
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# INFORMATION

Naval Ocean Systems Center
San Diego, California 92152
20 August 1981

NOSC Technical Document 314 (TD 314)

AERIAL SURVEYS OF BOWHEAD WHALES, NORTH SLOPE, ALASKA, by DK Ljungblad, MF Platter-Rieger, and FS Shipp, Jr., February 1980

## LITERATURE CHANGE

1. On page 33, under the heading CONCLUSIONS, the second sentence of paragraph 1 should be changed to read as follows:

"In the spring, the lease area is icebound and it is known that bowhead whales use offshore lead systems as migration routes."